IRON & STEEL

OF CANADA

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Devoted to the Iron, Steel, Foundry, Machinery and Metal-Working Trades, the Allied Coke and Coal Distillation Industry; to Steel Shipbuilding; and to the Mining and Utilization of Coal, Ferrous Ores, Fluxes and Refractories, all with Especial Reference to Canada.

F. W. GRAY, M.I.Min.E., Editor.

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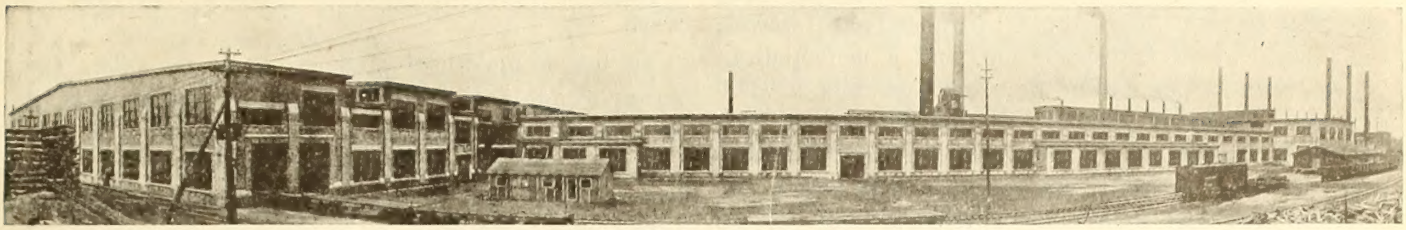

EDITORIAL

STEEL PRICES RELATIVE TO OTHER COMMODITIES.

Buying in the steel industry is plainly being withheld until purchasers are satisfied that commodity prices have found, not the bottom, but such temporary stability as shall attend the downward course of prices in 1921. Judging by the experience of previous high-price periods it seems likely that the curve of prices will have a general downward trend for a good many years to come—barring wars—but that this curve will show periods of flatness, and possibly occasional upward tendencies. On the whole, however, the trend must continue downwards to a point not yet ascertainable.

The downward tendency has probably gone too far in some commodities. Hides and leather, some base metals, silver, cocoa, meats and sugar have dropped below or close to pre-war price levels, largely as a result of large accumulations of stocks. Cotton, wheat, wool, silk are commodities in which the stocks are extremely large, and unsaleable at recent prices. In all these instances the effect has been to cause curtailment of production, although a great part of the world is suffering from a lack of these commodities, and there is reason to believe that under-consumption, rather than over-production is the determining factor. The whole world is engaged in a fight against cheapness, and, naturally, it will be a losing fight.

Commodity prices are a puzzling study. When Jevons, the great British authority on the coal trade, wrote his book "The Coal Question" in 1865, he looked for such a rise in coal production costs as would make the cost of fuel rise "perhaps within a lifetime, to a rate injurious to our commercial and manufacturing supremacy,' and suggested that this check to progress would become perceptible within a century. The son of Jevons, writing on the same matter in 1914, after the lapse of half the period mentioned by his father, found that instead of coal prices rising, they had fallen by about six per cent compared with 1865. Examination of the matter, with the aid of Sauerbeck's index numbers, disclosed, however, that after making allowance for the decrease in commodity prices, there had been a relative rise of 12 per cent in the price of coal. It is evident, therefore, that all commodity prices are relative to each other, and that before the steel industry can look for greatly increased business, it will have to become apparent to would-be purchasers that the price of steel has found its relative level. The lack of orders indicates that buyers think it has not found that level, and this places the steel manufacturer in an unenviable position, because the steel industry is not so much a prime producer as an assembler of three raw materials, namely coal, iron and fluxes. In regard to all these materials, the factor of labor cost is the determining one, with that of transportation costs coming next. Labor again is the chief factor in transportation charges. The wages of miners and railwaymen represent the peak of manual labor remuneration. These men are the aristocrats of labor, and their wages have been increased by from 150 to 200 per cent. A reduction of steel manufacturing costs can only be very partially effected by reduction of wages in the steel industry itself. As the steel industry and the railways are the largest users of coal, there seems little escape from the conclusion that until idleness at the steel plants has caused idleness at the coal and iron mines, the reduction of the number of those employed on the railways, and consequent reduction of wages among both miners and railwaymen, but little lowering in the costs of steel manufacture is possible, so far as the major factor of labor is concerned.

Under these circumstances, the buyers of steel—and there is little doubt that much steel for many necessary purposes is urgently required—will press their present advantage to an unwise and perilous conclusion if they insist that steel prices shall, like the prices of other commodities that have been instanced, drop to pre-war levels or thereabouts.

THE MONTREAL STEEL TRADES TARIFF MEMORANDUM.

January issue of "Iron & Steel" contained the full text of the memorandum presented to the Cabinet Committee on the Tariff by the Steel Company of Canada, a document that covered the case of the primary producers of pig-iron and steel in Canada. In this issue will be found a digest of the memorandum presented by the President of the Canadian Car & Foundry Company at Montreal, for and on behalf of the companies "located in Montreal, which use iron and steel as their principal material and manufacture various products therefrom."

Montreal is a growing metallurgical centre, as befits a locality so plentifully supplied with sources of power, on a highway of transportation, and a metropolitan centre with a population that now exceeds 900,000 persons. Together with certain districts of Ontario, Montreal has within the past few years seen a remarkable extension of United States interests, and in no industry has this been more noticeable than in the iron and steel trades, and in non-ferrous metallurgical enterprise also. Some significant testimonials to the effect of the Canadian tariff in encouraging the extension of United States export trade (to use a phrase of "Iron Age") to Canada by means of branch manufactories are to be found in the memorandum.

The Montreal hearing on the Cabinet Committee was marked by some searching comment and enquiry from Sir Henry Drayton, who showed a familiarity with the quite complex question of steel and iron importations that ensures, at any rate, an understanding handling of the question of revision of the steel and iron items in the Tariff Schedule.

Mr. Butler's statement that the steel industry in Canada has been built up against competition of unexampled severity is not an overdrawn statement. The result of the import tariff, as exemplified during the past few years, has been, by encouraging the coming of United States factories to Canada, to enlist the sources of American competition on our side. This outcome is a tribute to the foresight and wisdom of those who drew the original schedules, and augurs, doubtless, that no less ability will be shown in whatever revision of the Tariff may be recommended for the approval of Parliament at the ensuing Session.

TARIFF REVISION A CONTINUOUS PERFORMANCE.

The presentation of information to the Cabinet Committee on Tariff Revision came to an end in January, and the country now awaits the publication of the changes in the tariff schedule that the touring ministers and their advisers will propose.

The most practical suggestion for the future, was supported by the representatives of organized labor, who advocated the formation of a permanent advisory body, having much the same functions as the Committee of the Cabinet previously mentioned, with the great advantage that such a body could pursue its investigations under less distracting conditions, with ample time at its disposal, and could "carry on" from administration to administration without dissipating the accumulation of data and the wisdom that proceeds from knowledge, that would be the most valuable outcome of the continuous labors of such an advisory body as is suggested. Exception has been taken to the suggestion of the labor representatives as having proposed the formation of a new legislative body, infringing the functions of Parliament, but this, of course, would be a palpable absurdity, and was certainly not put forward.

To use a biological analogy, it is an axiom that power of adaptation to a changing environment is the measure of the persistence of a growing organism. Canada is a growing nation, surrounded by one of the most difficult environments—in regard to her political permanence—that ever fell to the lot of a young people.

The industrial trend of Canada has as yet only developed in faint outline. There is some reason to believe that, as has been the case in the United States, the centres of industrial production, and the geographical centre of population is shifting westward. A recent paper by members of the Geological Survey of the United States (*) states that since 1790 the centre of population in that country has moved westwards at the rate of 45 miles a year.

The westward movement cannot in Canada pursue the orderly progression that it has followed in the United States, because of the intervention between the settled East and the settled West of Canada of the barren apex of the pre-Cambrian shield. For this reason the concentration of Canadian population is likely to occur in two widely separated continental localities, and the balance of power will eventually pass to the West by reason of the concentration of 99.3 per cent of the fuel reserves of Canada west of Winnipeg.

It is not yet possible to forecast the form of the industrial evolution of the West, but, predicated on the preponderance of its fuel resources, it will exceed anything in North America west of Chicago. This much at least is certain.

Our transportation highways, rail, water, and maybe air routes, have not yet assumed final shape, nor is it possible to say how these will be affected by coming preponderance of industry nearer to the Pacific than to the Atlantic Coast.

The composition of our population is not yet determined. Invention and mineral discovery have to be taken into account. Our future is largely bound up with the fiscal policies of the United States and the Empire, and in neither instance is there any assurance of continuity or fixity of policy.

It is evident that there are a sufficient variety of influences preparing to act upon the national evolution of Canada to make it impossible, and even preposterous, for any political party to frame a hard and fast programme for the future, and that from time to time adjustments will be required in all international relationship that find expression through what is called the "tariff."

Such adjustments will call for statemanship of the

(*) "Geographical Shifts in Coal Production" F. G. Tryon and W. F. McKenney, U. S. Geological Survey,

most skilled character, statesmanship that can take both a forward and a backward view. It is fair to assume that a correct vision of the future is best obtained through exact knowledge of the past, and if there is any branch of political science in which such knowledge is desirable and valuable, it is in connection with international trade exchange.

The phrase "take the tariff out of politics" implies misunderstanding, because tariff is politics, and for the sake of international amity the more politic this country's course the smoother it will be found.

An instance of impolitic action is to be seen in the Emergency Tariff Bill now being debated before the United States Senate. This bill, which is in reality a phase of the mistaken and hopeless fight now being waged against the fall of commodity prices to peace levels, will not subsequently be regarded as expressing anything more than the ebullition of the moment. All campaign literature and talk is open to the same objection, and the desirability to dissociate tariff revision — which is a continuous performance — from ephemeral political feeling and partiality, is what people mean when they say "take the tariff out of politics."

A permanent advisory tariff committee seems indicated as the only way in which a continuity of policy can be achieved in a matter that necessarily will call for continuity of action so long as Canada remains a nation.

INDUSTRIAL FATIGUE IN STEEL WORKS.

The Report of the Industrial Fatigue Research Board in Great Britain is re-produced in condensed form in this issue, and shows that iron and steel practice is marked in Britain by the retention of many forms of manual labour that could be with advantage abolished in favour of mechanical devices. The report speaks of barrow-men employed in charging blastfurnaces by hand, the hand-charging of open-hearth furnaces, the exposure of blast-furnace workers to the weather, and other practices that have a strange sound on this side of the water. Hand stoking of boilers is naturally noted as an unnecessary cause of fatigue, and the poor layout of coal platforms at boiler bunkers is noted as causing unnecessary weight-lifting that it would have been the simplest matter to remedy.

From a medical investigator, the following observation is interesting: "In only one works did the blast-furnaces produce slightly more iron than was required for the steel furnaces, the steel furnaces produce slightly more steel than was required for the rolling mills, and the soaking pits supply sufficient ingots to keep the mills running with no delays, other than from unavoidable causes of machinery breakdown."

The ideal always eludes us, and in steel works, as in other branches of endeavour, "Man is not, but always to be, blest." There is quite a lot in what the doctor says, all the same.

MANIFEST DESIRE TO UTILIZE NATIVE IRON-ORES IN NORTH-WESTERN ONTARIO.

A widespread feeling is abroad in such centres of northwestern Ontario as Sudbury, Sault Ste. Marie and Port Arthur, that some attempt should be made to utilize the native iron-ores of Ontario. A joint committee from the Associated Boards of Trade of Ontario and the Canadian Institute of Mining and Metallurgy expects to wait upon the Federal Cabinet at Ottawa during the coming session to again urge a bounty on iron ores mined in Canada. The progress of the beneficiation experiment at Babbitt, the attention being paid to the study of low-grade iron-ores by the United States Bureau of Mines, the annually decreasing percentage of iron content in the annually increasing shipments of Lake ores, the fall of domestic iron-ore production in Canada during 1920 to a new low mark, and the progress made by Canadian inventors in beneficiation processes adapted to Canadian conditions, all are reasons for much uneasiness in the minds of those who desire to see Canada a little less dependent on imports of iron ore and its products.

The assistance of the Ontario Mine Operators Association and the Canadian Manufacturers' Association is also promised in representing the case for an iron-ore bounty to the Federal Government.

At Sault Ste. Marie, the City Council, the Board of Trade, and the Independent Labor Party have united in requesting the Ontario Government to make a geological survey of hematite occurrences reported near the Sault, this action being a reflex of the prospecting classes which the Ontario Government has been providing at various mining centres in the Province.

The situation is a difficult and complex one, and one moreover that it is not possible to view entirely from an economic standpoint.

The economic view, considered apart from all questions of national self-sufficiency is well expressed by "American Metal Market", which paper writing in entirely another connection — states: "This thousand mile journey of Lake Superior ore has always been a popular subject...but the fact is it is worth it. There are iron ores in Alabama which do not need to be hauled at all, yet the practical proof is that twenty years ago Alabama made about 10 per cent of our pig-iron, and last year made less than 7 per cent." It is quite evident, therefore, that considered on purely economic grounds it will pay Canadian users of iron ore to import Lake ores in preference to utilizing native ores in ordinary blast-furnace practice, for many years to come.

The national view is one of alarm at a dependency upon imported ores to the virtual exclusion of the utilization, the investigation and all purposeful interest in our native deposits, and this view is not so much one that should be urged by those actually engaged in the iron and steel industry in Canada as a

viewpoint that should originate with national leaders, because it is based on national urgency and not on commercial exigencies.

The pressure upon governments must, however, always originate with private individuals, the government being merely a reflex of aggregate private opinion. It is therefore encouraging to see so general an expression of public opinion upon a question that is first and foremost a phase of national self-defence and protection, using that such hackneyed word in its original and truest sense.

The occurrences of iron-ore in Canada are fairly well-known, and the geological surveys, both federal and provincial, have not been lacking in examining and recording in available form more or less exact information concerning domestic deposits, as will have been observed by those who have followed Mr. Grove's series of articles that are concluded in this issue.

In regard to beneficiation processes, also, much real progress has been made in Ontario, almost altogether by private enterprise, except for the pioneering experiments in the application of electric power to iron-ore reduction conducted by the Mines Branch under Dr. Haanel some fifteen years ago.

It is also probable that both federal and provincial governments are following closely the progress of beneficiation experiments in the United States, and it is suggested that — apart from such stimulus as the various governments can give by offering bounties, there is a field of investigation of processes, such as is being undertaken by the United States Bureau of Mines, which our governments would do very well to enter and enlarge by generous appropriations and by definite encouragement.

PROTECTION FOR CRUCIBLE STEEL INDUSTRY.

The question of general tariff revision is as much to the fore in the United States as it is in Canada, and recently representatives of the crucible steel industry in the United States appeared before a congressional committee to urge increased tariff protection for that industry. The argument presented was that the crucible steel industry was not a tonnage industry comparable with the manufacture of pig iron and crude steel, but was essentially a handcraft industry in which machinery played a minor part. The investment required, the raw materials, and the relatively small production differentiated the crucible steel industry in a marked way, and protection was asked against the cheaper rate of wages paid to the European hand-worker in crucible-steel manufacture. It is claimed that the crucible steel industry, bearing in mind these differences, has not been relatively so well protected as the tonnage steel industry.

The Committee of the crucible steel interests stated in conclusion: "An equitable degree of protection for "the labor and capital in this industry would be se- "cured by a scale of duties ascending with the import "valuation. The higher the import value, the higher "should be the rate of duty, because almost without "exception, the increased value of steel is due to the "additional proportion of labor represented in its "production."

An interesting feature, in its bearing on Canadian exports, was that the tungsten and magnesite interests did not make any effort to press their representations at this time, it being considered, according to the Washington correspondent of "Iron Age" "a certainty "that the new tariff law will contain provisions for "the protection of the tungsten and magnesite indus- "tries developed during the war similar to those in "the emergency bills now in the Senate."

The crucible steel and the alloy steel industry in Canada are quite similarly situated to these industries in the States. Recently, competition from Europe has become intensified, and there has been serious shrinkage of Canadian output as a consequence.

The advantage that Canada has in the already large development of moderately priced hydro-electric power, and the still greater possibilities of such development; and the adaptability of the electric furnace to certain well-known types of Canadian iron ores and alloy minerals, is probably not overlooked by competitors in the United States.

It is, however, to be expected that any permanent status the crucible and alloy steel industries may attain in the United States, or in Canada, or any marked advantage over the similar industries in Europe, will be based, not so much on tariff protection, but on quality of product and the progress of invention.

SCIENTIFIC AGRICULTURE.

"Scientific Agriculture" the official organ of the Canadian Society of Technical Agriculturists, is the latest professional periodical to appear in Canada. Agriculture has not at first sight many points of contact with the steel industry, but it has some, notably the provision of phosphorous-bearing slags for fertilizers, and the manufacture of ammonium sulphate for the same purpose. Agriculturists are also today among the chief users of motor-driven machinery, as a visit to any Canadian Fall fair will disclose. The supply of motor fuel as a by-product of the destructive distillation of coal will persist long after the petroleum wells have dried up, and the steel companies of Canada are in the best position to supply the demand for motor-fuel that agriculturists of the future will demand in ever-growing quantity. Farm tractors to the extent of $14,000,000 in value have been admitted to Canada in one year, as a non-dutiable product, and this industry has barely commenced to popularise its wares in Canada. Several Canadian houses have made a good start in the manufacture of farm tractors, but their finan-

cial success in face of United States competition is not yet assured.

"Technical agriculture" that does not cover the mechanical side of farm life would omit a very important phase, and "Rural Engineering" is a well-defined branch of study in agricultural colleges in Canada.

An unusual, and a pleasing feature, of the new monthly magazine, is a section in the French language, a recognition of the pioneering effort and present importance of the French-speaking Canadian in agriculture.

SHIPBUILDING.

The Summer of 1921 will probably see a decision of the question whether steel shipbuilding in Canada can persist as a permanent industry. At Prince Rupert the Shipyard is in the hands of a receiver, as is also the Dominion Yard in Toronto. Two of the yards in Vancouver, and one in Victoria have no orders after completion of present programme. Vickers of Montreal are in similar case. At Port Arthur the shipyard has turned to manufacturing pulp and paper machinery and mechanical loaders for mines. Collingwood Shipyard has no orders beyond repair work and the finishing of the Dominion Yard's partially completed vessels at Toronto. The Three Rivers Shipyard has no orders, and the Levis Shipyards is approaching the close of its programme. The Nova Scotia Steel Company will not likely lay down further ships after completion of those in hand. The Halifax Shipyards, which has probably more real business in sight than any other Canadian yard, has only work for its employees until the late Summer.

Similar conditions are to be noted in Great Britain, but with the difference that steel shipbuilding is an old-established industry in Britain, whereas in Canada, it is a new and easily-killed industry. The British yards seem likely to be relieved of much armanent work, which will leave them open for commercial shipbuilding. If the Canadian Government has any further assistance for the shipbuilding industry in mind, speed in application is necessary, as otherwise, by the late Summer, the industry will be beyond hope of resuscitation.

CORRESPONDENCE.

UNIVERSITY OF ALBERTA.

Edmonton, January 24, 1921.

To the Secretary Iron and Steel Section of the Canadian Institute of Mining and Metallurgy:

Dear Sir,—At a meeting of Council of this Association, held at Calgary, December 27th, 1920, a discussion of interests of professional engineers was held and a resolution was carried "that enquiry be made of Engineering Institute of Canada, the Canadian Institute of Mining and Metallurgy, and Provincial Associations, asking their point of view as to the advisability of holding at an early date a joint meeting of delegates from the above-named organizations to discuss matters of common interest"; such as correlation of provincial association objects and the possible formation of a federation of these bodies to co-ordinate the efforts of all in striving to obtain better conditions for the profession.

The formation of such a body would enable the full weight of all engineering opinion in this country to be directed as may seem wise. It also seems possible that concerted efforts of already formed provincial associations would materially assist engineers in other provinces to secure their legislation.

It is suggested that each organization should bear its proper proportion of the expense involved. In order to provide a next step, in the event of your approval of the above, it is further suggested that your reply should include some indication of your choice of meeting place, number of delegates, and a suggestion as to who might convene the meeting. You are asked to assist in carrying out the suggestions in the above, if you approve, by using your influence with your parent organization.

Yours faithfully,

R. S. L. WILSON,

Registrar and Secretary.

DESULPHURISING OF COKE BY HYDROGEN.

For metallurgists the presence of sulphur in coke is very objectionable as is well known and the trouble is likely to become more serious with inferior coal. Most of the sulphur in the coke comes from the pyrites, and the pyrites can, to a certain extent, be removed by washing the coal. The washing does not affect the organically-bound sulphur, and it barely reduces the sulphur content of the coal by one-half in the best case. Various other means of getting rid of the sulphur have been tried, mainly by converting the sulphur into a compound which can either be volatilised or be eliminated by subsequent leaching. Heating of the coal with steam or air, with chlorine, sodium chloride, carbon monoxide or manganese dioxide has been proposed. None of these proposals have been adopted on a large scale, however, because they are either wasteful or too complicated. In analytical practice coal can completely be desulphurised by hydrogen. For that purpose, the powdered coal is mixed with zinc or some other metal which will generate hydrogen on the addition of hydrochloric acid; this hydrogen changes all the sulphur into sulphuretted hydrogen, which escapes. It occurred to Alfred R. Powell, of the United States Bureau of Mines Experiment Station at Pittsburgh, that coal might be purified of sulphur by passing hydrogen through the coking mass. The experiments so far conducted are promising. But the coal must be heated for three hours up to 1,000 degrees C. when hydrogen is used, and for longer periods if coke-oven gas is to be utilised, though some of the reactions take place at a temperature of 500 degres C. These experiments as yet have only been made on a very small scale, however, so that the practical difficulties remain an unknown factor.

The Steel Industry and the Tariff

Information presented before the Committee of the Cabinet on Tariff in Montreal during November 1920.

A memorandum was prepared by the Montreal Committee of the Canadian Manufacturers' Association covering the Iron and Steel industry within the district of Montreal, for presentation to the Committee of the Cabinet on the Tariff. The memorandum was presented, on behalf of the industry, by Mr. W. W. Butler, President of the Canadian Car & Foundry Company.

A digest of the information presented is as follows:

A table was submitted showing the imports of iron and steel into Canada for the year ended 31st March 1920, totalling $189,897,602 in value (of which amount $20,849,226 was the value of articles admitted without duty consisting principally of manufactured products, some of which are not yet made in Canada). A large proportion of the pulp and paper machinery used in Canada has been in the past, imported, but as a result of the growth of the industry the manufacture of these machines has been commenced in Canada, and this machinery will now be obtainable at a distinctly lower price than has been paid for the imported machinery.

The memorandum stated that the production of many iron and steel products had not been attempted in Canada;

a. Because of the limited Canadian market, and
b. Because of the lack of Capital.

Canadian Steel Industry Confronted with Unexampled Competition.

Except on the Atlantic seaboard, Canada is under a heavy disadvantage so far as the iron and steel industry is concerned. Both coal and iron ore have to be imported and the case of bituminous coal there is a revenue import duty.

Transportation costs on such raw materials add to the cost of production.

Then too, the Canadian iron and steel industry in both its primary and secondary phases is confronted with the competition of highly organized, remarkably developed and financially strong companies in the United States, with plants situated within a short distance of the international boundry along a stretch of more than 3,000 miles. No other country in the history of the world ever faced such competition.

Free Trade and Lowered Tariffs Injurious Even to Well-Established Industries.

The iron and steel industry in the United States was built up by high protective duties before ocean transportation had reached anything like its present development, and while the comparative isolation of the United States promoted an independent industrial growth. The Iron and Steel industries in Great Britain attained a position of world importance before the industries of other countries were able to offer serious competition. But after free trade was adopted by the United Kingdom, while Germany, Belgium and other European countries protected their growing iron and steel industries by tariff duties, the British lead was steadily reduced and at the beginning of the war Germany was supplying a very considerable part of Great Britain's requirements of iron and Steel. Moreover, German manufactures were rapidly increasing their sales in almost every country in the world, and German iron and steel products were even being sold in increasing quantities in the United States following the lowering of the United States tariff in 1913.

The Defence Value of Iron & Steel Industry.

To a remarkable extent modern civilization is built on iron and steel, and no country which has any ambition for industrial greatness can afford to neglect the iron and steel manufacturing industry. The national value of such industry was demonstrated during the war, when the iron and steel concerns throughout Canada, with plants and trained organizations already available, were able to turn almost overnight to the manufacture of munitions of war, with the result that Canada contributed shells, steel rails, railroad equipment and other supplies in quantities which had not an unimportant bearing upon the outcome of the war.

Outside Dependence Undesirable.

But it is not alone as a resource in time of war that the iron and steel manufacturing industry is of national importance. Canada cannot afford to be dependent upon the United States or any other country for essential supplies of peace-time products of iron and steel. During the war and also since the Armistice, Canadian users of iron and steel, and iron and steel manufacturers who have been obliged to import from the United States in many instances, have been required to pay higher prices than the prices of similar goods to domestic purchasers in the United States. Manufacturers abroad look to this country as an outlet for surplus stocks.

United States Encourages Export Combinations.

Manufacturers abroad look to this country as an outlet for surplus stocks under conditions of slack trade in their own home market, and cut their prices to the lowest possible figures in an effort to capture Canadian business but yet give a preference to their domestic trade in time of shortage. It is also to be noted that the laws of the United States now allow combinations of iron and steel and other manufacturing interests to control and develop export business, although such combinations are not permitted to function so far as the United States home market is concerned. Under conditions such as obtained at the present time, Canada is paying heavily in exchange because the Canadian Iron and Steel industries are not able to supply a large part of the country's requirements. All imports of manufactured goods which could be made in the Dominion increase unnecessarily the cost to every user of such essential commodities as fuel, cotton, oil and other products which are not produced here. They keep our international trade account overbalanced and our money at a discount in the United States and other countries whose currencies are approximately at a parity with gold.

Peace Readjustment Has Intensified Competition.

The war resulted in a very great expansion of the Canadian iron and steel plants, both to supply war

material and also to meet an export demand at a time when iron and steel manufactures of all kinds were in great demand. When war business was discontinued, many of the plants had a capacity far in excess to their pre-war production, and an effort has been made to employ such plants and equipment and the personnel of trained workers which was developed by war experience on the manufacture of peace time products. These new lines of production have been undertaken at a time when the great factories in the United States are commencing to feel a slackening of trade and are anxious to gain the Canadian market to the utmost possible extent. Already Canadian business, too, has slackened, and the problem for us is a more difficult one than for the great companies in the United States, because our war time expansion was relatively greater while our resources with which to withstand the difficulties of readjustment are not so large. A number of the companies operating here are now working considerably below capacity, and there is some unemployment with the prospect of more during the winter.

The iron and steel working industries require a large investment of capital and, to an even greater extent than is true of other manufacturing enterprises, success depends upon a large volume of business and steady operations. The home market, if assured by reasonable tariff protection to the Canadian manufacturing concerns, and the Canadian iron and steel workers can sustain the war-developed capacity of the plants here and in addition can support and justify a much larger production. More capital is needed too, but this cannot be secured unless stability in the fiscal policy of the Dominion is assured and the home market protected for Canadian industry.

At best the Canadian home market is none too large to make possible the success and economical manufacture of iron and steel products here. Already a long free-list and low tariff-duties on various iron and steel products for special use have resulted in giving to companies in the United States a considerable share of the Dominion trade. If the Canadian companies be required to continue to share that market, and if by a reduction in the present customs a still larger share be given to industries in the United States which already are insured the advantage of quantity production and specialization by reason of their own tremendous home market, the development of such Canadian companies will be hampered and many lines of production recently undertaken will have to be discontinued. Indeed, the retention of at least the present amount of protection is absolutely vital to our industries.

Extent of the Montreal Industry.

These representations are made primarily on behalf of the Companies in the Montreal District which manufacture railroad equipment, specialties and truck supplies, valves and pipe fittings bridge and structural steel, machinery, air-tool drills, compressors, bells and padlocks, wire rope and wire cloth. Some fifteen of such companies for which figures have been obtained have an aggregated capital of approximately $62,000,000. They employ over 12,000 employees and last year distributed about $20,000,000 in payment to their workers.

The Tariff Has Brought United States Branch Factories to Canada.

Five of the fifteen companies included in the enquiry are branch plants of big United States manufacturing concerns which were induced to locate in Canada in order to share in the Canadian protected home market. These companies are quite able to supply the market here from their United States factories, and there is little doubt but that they would be forced by competition from other manufacturers in the United States to do so if the Canadian tariff were withdrawn or reduced. The treasurer of one of these branches, which represents an investment in Canada of $5,000,000 and employs 600 persons, write under date of September 29, 1920:

"Although we are a Canadian organization, we are closely connected with the....Company, which has large manufactures at .... and .... which factories are entirely capable of taking care of the demands of the trade in Canada for valves and fittings. In other words, except for the tariff, which permits a smaller plant with a small output to operate with a reasonable amount of protection,—as a Canadian organization would not have been formed, nor the works built at Montreal."

The executive head of another such branch plant says:

"If the tariff were removed the United States manufacturers would close up...Under free trade we would be jobbers of the United States manufactured articles, and practically the whole of wages now being paid to Canadian workers would go across the line."

A third letter reads in part:

"The proportion of goods manufactured at our Montreal Plant is 10 per cent of our whole sales, and the policy of this company is to gradually increase our Canadian plant until such time as we can manufacture here a complete line of air tools, comprising riveting and chipping hammers, drills, compressors, etc., and thereby eliminate all importations from the United States. In that event you can readily see it would mean employment of about 300 hands, with an estimated pay roll of around $400,000 to $500,000 in the course of the next few years.

If the tariff is removed it would certainly mean that we would have to close down our factory forthwith... Our Company's future policy in Canada depends entirely upon the attitude taken by the Canadian Government on the tariff question. If the tariff is removed, then the Canadian factory will be shut down and everything imported free. On the other hand, if a reasonable tariff is still imposed, the Company will be prepared to spend a very considerable sum in the near future on plant extention and employ considerably more labor."

A Concrete Example.

A British Company which has made an investigation of $3,000,000 in works in Montreal affords a concrete example of how the withholding of adequate protection may stop desirable industrial expansion. In the expectation of the Government giving favorable consideration to its application in the matter of tariff protection, the Company prepared to manufacture steel tires. A beginning was actually made, but the Company has been forced by competition from the United States to discontinue the production of such tires in Canada.

Pulp and Paper Machinery and Water Wheels.

Reference has already been made to the fact that all the pulp and paper making machinery in actual use in Canada is imported. A Canadian Company has recently been incorporated to manufacture such machinery in Canada, and also to make hydraulic turbi-

ties, pumps and accessories. Heretofore no plants in the Dominion have been equipped to manufacture the larger hydraulic turbines for hydro-electric developments. An official of the Company has supplied the following information.

"Our present number of employees is 525 and our payroll is about $85,000 per month. We expect to increase the number of employees to 650, within six months, which would bring our monthly payroll to $100,000. We have already spent on our shops and equipment upward of $3,000,000, and large extentions to our plants are under contemplation and will be built, providing that they are warranted by the business. It was at the earnest solicitation of several firms and individuals interested in the development of Canadian water powers that we took up the manufacture of large turbines, and our investment in the expensive shop equipment required was based upon the continuance of the present tariff. The reduction of the protection given us would result in the closing down of this industry."

Removal of Tariff Would not Lower Prices to Canadian Consumer.

Attempts on the part of the United States manufacturers to use the Canadian market in time of business depression as an outlet for their surplus stocks, which in some instances are offered below the cost of production constitute a continued menace to the Canadian industries. A Canadian Manufacture of long experience in the making and marketing of spring and track tools says:

"Without adequate tariff protection, the Canadian manufacturers of spring and track tools cannot exist.... At periods such as we have been experiencing for the last two years, the United States companies have preferred their own market and have gone so far as to refuse to quote prices on shipments to Canada.... In hard times the United States manufacturers dumped their output in this market, notwithstanding the dumping clause, which has never functioned in these lines so far as we are aware."

"If the Canadian market were thrown open under free trade or lower tariff conditions, and the Canadian factories were forced out of business, there is no sound basis for the belief that the Canadian users of these products would be able to buy at lower prices. Experience has shown that imported manufactured goods sell at higher prices in those countries in which there is no competition from domestic manufacturers. Inversely, the establishment of domestic manufacturing industry almost invariably results in a reduction of the selling price of the imported commodities, and the consumer is able to buy at lower prices whether he takes the imported article or that of domestic manufacture.

European Competition.

In some lines of manufactured iron and steel products there was exceedingly keen competition before the war from British manufacturers to send their goods into Canada under the British preferential tariff. At the present time the British iron and steel producer has the advantage of exchange in selling in this market, and practically on all lines such exchange advantage more than offsets the present Canadian tariff on importations from Great Britain.

Certain lines of iron and steel products from Belgium, Germany and other European countries must also be looked for, especially in view of the decided advantages which exchange and cheaper labor give to the manufactures of these countries.

Protection Necessary to Canadian Iron & Steel Industry.

Canadian manufacturers of iron and steel products need adequate protection to enable them to get the largest volume of business that the Canadian home market will support, and thus produce at the lowest cost; to offset the disadvantages under which they are operating as compared with plants in the United States and elsewhere; to offset the advantages which low westbound ocean rates and the exchange situation now give to British and European manufacturers who have products to sell in the Canadian market; and to prevent Canada being used as a dumping ground for iron and steel products of other countries now that their home demand is slackening. While the principle of the anti-dumping law is sound, there can be no question but that such law does not prevent entirely the practice of dumping, and that the regulations in many cases are circumvented.

In conclusion, these representations are made on behalf of the following companies located in the City of Montreal, all of which use iron and steel as their principal material and manufacture various products therefrom:—

Armstrong Whitworth of Canada, Limited.
Canada Axe & Harvest Tool Mfg. Co.
Canadian Iron Foundries, Ltd.
Canadian Pneumatic Tool Co. Ltd.
Canadian Car & Foundry Co. Ltd.
Central, Engineering Company.
C. O. Clark & Bros.
Crane Ltd.
B. J. Coghlin & Co. Ltd.
Darling Bros.
Dominion Bridge Co. Ltd.
Dominion Engineering Works, Ltd.
Dominion Wire Rope Co. Ltd.
J. B. Dore & Fils.
Gillette Safety Razor Co. Ltd.
The Grimm Mfg. Co. Ltd.
Hydraulic Machinery Co. Ltd.
Jenkins Bros. Ltd.
C. H. Johnson & Sons, Ltd.
G. & J. Lunn & Company.
Alex. McKay Boiler Works.
Miller Bros. Co. Ltd.
Miller Bros. & Sons, Ltd.
Montreal Locomotive Works.
Montreal Hardware Mfg. Co. Ltd.
National Acme Mfg. Co.
Hiram L. Piper Co. Ltd.
Precision Tool & Machine Co.
Phoenix Bridge & Iron Works.
Quality Tool Works.
St. Lawrence Iron Foundry Co.
St. Lawrence Welding Co.
A. B. See Electric Elevator Co. Ltd.
Simonds Canada Saw Co. Ltd.
Vapor Car Heating Co.
H. G. Vogel Company.

COMPANY NOTES

The General Outlook.

Without desire to be pessimistic, the general trade outlook in Canada, particularly in the primary plants and in steel shipbuilding is depressed, although there seems reason to believe that improvement is within sight. Wage readjustments have taken place in a number of plants. The Dominion Steel Corporation and the Steel Company of Canada have both announced a reduction of approximately 20 per cent in wages, following similar reductions in independent plants in the United States.

The Vickers Company in Montreal has notified its employees to avoid long-term rental leases if possible in view of the likelihood that after the 1st of May a drastic reduction in the number of employees will be forced by the completion of ship orders on hand. The railways refrain from equipment orders, although the car companies are probably better situated in regard to orders than the steel plants.

The wages of coal-miners and railway employees in Canada and the United States are abnormally high, and until they are reduced the production of pig-iron cannot be accomplished at anything like pre-war figures, no matter how drastic the wage reductions may be in the steel industry itself.

The executives of the Canadian steel companies express themselves optimistically regarding the future of the industry, but the present lull in orders emphasises their statements that full employment must await a reduction in the cost of raw materials, the further progress of readjustment in the steel trade of the United States — now apparently about completed — and resumption of buying by the Canadian railways.

Algoma Steel Corporation's Half-Yearly Statement.

Lake Superior Corporation has issued a report for the half-year ending December 31. The Algoma Steel shows increases of 88,000 tons of coke, and 50.000 tons of steel ingots, while pig iron production at 233,-332 tons is almost double production in the corresponding period of 1919. Shipments of iron and steel for the period were 244,991 tons, an increase of over 100,000 tons.

Unfilled orders for iron and steel at the close of the year were 69,500 tons and the directors announce that two rail contracts have been closed for delivery before June and other contracts in course of completion. Coal and limestone production shows little change.

Ontario Steel Products, Ltd.

Reports received by the directors of Ontario Steel Products, Limited, at a recent meeting showed that business was looking up. More orders were coming in, and business appeared to be looking brighter in every way. The plants of Chatham and Gananoque are said to be running at considerably more than half capacity.

Nova Scotia Steel 1920 Production.

Nova Scotia Steel & Coal Co. in the year 1920 was able to show substantial increases in production and shipments as compared with 1919. Comparative operating record follows:

	Year to Dec. 31st	
Coal (Gross Tons)	1920	1919
Output	633,845	550,964
Shipments	355,491	325,255
Products.		
Iron and Steel (Net Tons)		
Pig iron	73,829	35,676
Blooms and billets	101,192	48,515
Merchant mills	58,232	35,172
Plate	1,618	2,837
Bolt and nut dept.	5,873	6,575
Finishing dept.	6,057	4,395
Axles	11,146	3,788
Heavy forgings	1,276	1,257
Shipments.		
Pig iron	1,023	....
Ingots	....	....
Blooms and billets	23,880	3,947
Merchant mills	43,583	23,415
Plate	1,509	4,287
Bolt and nut dept.	5,738	4,048
Finishing dept.	6,102	4,008
Axles	11,280	3,722
Heavy forgings	1,107	1,359
Total	94,222	44,786
Receipts.		
Coal (Gross Tons)	261,267	219,898
Wabana Ore (Gross Tons)	124,014	50,660
Limestone (Net Tons)	58,929	32,430
Wabana Iron Ore.		
Output (Gross Tons)	262,755	213,410
Shipments (Gross Tons)	12,375	....

Canadian Car & Foundry Company's Annual Meeting.

The annual general meeting of the Canadian Car & Foundry Company was held in Montreal on the 27th January. The financial statement was summarised in the January issue.

Mr. W. W. Butler, the President of the Company reviewed the year's operations, and referred to the future laying particular stress on the desirability that the railways in Canada should now give out equipment orders.

"In 1920", Mr. Butler stated, "we had business on our books amounting to $8,000,000, at the beginning of the 1920-21 year the business amounted to $26,000,-000, and at the present time we have business on our books amounting to $14,000,000.

"When last year began we hoped that 1920 would be the best year in the history of the Canadian Car Company. We assumed this from statements made by the Canadian railroads about the equipment orders we were going to receive. For some reason these orders have been held in abeyance, so that despite the good year the company has come through it has been a disappointment to us.

"Summing up the year's work, at one time we had orders on our books for $34,000,000, but we were unable to realize on this business owing to the fact that we were unable to get materials to fill orders because of strikes and railroad embargoes, etc. The result was that with 7,000 cars to build we turned out a little over 1,700. But notwithstanding the fact that we had to depend on our subsidiary companies such as malleables,

[illegible]

Speaking of the future of the company Mr. Butler affirms that the railroads of the country must buy equipment, particularly the Canadian Government roads, which are particularly short and he said it was hard to understand why the orders have been held in abeyance. Among railroad men it is stated that unless the Canadian National increases its equipment sufficiently [illegible] with the business offering there is no hope of wiping out the deficit in the earnings of the road each year. The pressure of business and the absolute necessity for the equipment, is the reason for the Company's expectation that the orders must come soon. The President states that with the business on hand, if the Government moves quickly, a record year should result for the car enterprise, but that if the Government still continues to hold off, next year will be again a dragging one.

"We have the most complete car manufacturing enterprise in the world," says Mr. Butler. "We are self contained. We produce everything we need. We have even timber limits of our own. We make everything that goes into the manufacture of cars and can do the business on as reasonable a scale as any company in the world, and our capacity is 30,000 cars annually. During the year we have paid out in wages $7,091,214. That is something that should be taken into consideration."

DOMINION ENGINEERING WORKS, LIMITED.

The Dominion Bridge Company's subsidiary, Dominion Engineering Works, Ltd., is making excellent progress in the manufacture of paper-mill machinery. The two 166-inch high-speed newsprint machines, described in our June 1920 issue as being under construction, are now completed, and one of the machines is satisfactorily running at Grand'Mère. The Laurentide officials express themselves as well satisfied with the machine, and believed it to be the last word in newsprint machines, and superior to any machine previously used in Canada, both in regard to workmanship and quality of material.

A 148-inch Harper tissue machine has been built, and is partially erected for the Interlake Tissue Mills.

In addition to two 20,000 h.p. water-wheel units under construction for the Laurentide Company, the Company has orders for two 10,800 h.p., and one 1,500 h.p. exciter turbine sets for the Cedar Rapids Plant of the Montreal Light, Heat & Power Co.. There is also building four 2,500 h.p. units for the Spruce Falls Company and one 41,000 h.p. for the Shawinigan Water & Power Company. This last named water-wheel unit, as well as the two main Cedar Rapids units mentioned, will be the largest in the world. In addition, the Company is building several Johnson valves, including a very large one for the Shawinigan plant.

The lull in business which this Company has recently experienced, along with all other metal-working plants, is believed to be quite temporary, and is not ascribed to any lack of work in prospect, but to the difficulty of raising large sums for capital expenditure at this time without incurring undue interest liabilities. A number of very large projects are under consideration, and a heavy volume of business is anticipated when financial conditions become less strained.

1920 YEARBOOK OF NATIONAL ASSOCIATION OF COST ACCOUNTANTS (U. S.)

The 1920 year Book of the National Association of Cost Accountants which has just been published is an attractive volume which ought to prove of real value to all men interested in cost work. In addition to the reports of the various officers and committees and a list of the members of the Association, it contains a complete report of all the papers delivered at the Annual Convention at Atlantic City, together with the discussions which followed each of these papers. This section contains a fund of practical cost information of a type which does not as a rule find its way into print. The Atlantic City Convention was probably the most important gathering of cost men which has been held in North America and the opinions of the men who took part in this conference are worthy of some study.

One session of the Convention was devoted to a discussion of uniform cost accounting from the standpoint of the Trade Associations. During this session papers were presented by the following gentlemen: J. Linton Engle, Vice-President, United Typothetae of America; Grant A. McClatchie, Secretary, United States Finishing Company; William B. Reed, Secretary, National Coal Association; William B. Baker, Secretary, National Association of Chair Manufacturers; Chas. B. Stevenson, of the Folding Box Manufacturers Association and the Glass Bottle Manufacturers Association. These papers were followed by a general discussion of the subject.

Other topics covered in the proceedings of the Convention are "The Relation of Cost Accounting to Business Management" from the standpoint of the Professional Accountant, by William M. Lybrand, of Lybrand, Ross Brothers and Montgomery, and from the standpoint of the Business Executive by William B. Ferguson, of the Philadelphia Engineering and Sales Corporation; "Some Special Aspects of the Problem of Overhead Distribution and Application" by Frank Wilbur Main, of Main & Company, Pittsburg; "Under What Conditions Should Schedule Costs Be Used and How Should They Be Proved?" by J. P. Jordan, of C. E. Knoeppel & Co.; "Some Questions in the Determination of Lumber Costs" by A. J. Redemski, Industrial Engineer, Chicago.

The Year Book is distributed to all members of the Association. We are informed by the Secretary that there are a few copies available for general distribution to men interested in cost questions. The offices of the Association are in Rooms 2546-2548 Woolworth Building, 233 Broadway, New York City.

William Beardmore & Company Limited, whose steel works are at Glasgow and naval construction works at Dalmuir, have opened a Canadian office at 285 Beaver Hall Hill, Montreal in charge of Mr. Breen Kennedy, handling the following lines:—

Steel shafting and forgings up to all sizes. Tyres and axles, wheels and axles complete, small tools, jigs and fixtures, locomotives of every variety (steam, petrol and electric.) Lapwelded furnaces corrugated or plain, flanging work of all kinds, sheets, ship and boiler plates and sections, water-tube, Scotch and locomotive boilers, steam turbo, Beardmore-Tosi Diesel and Beardmore Crude oil engines, centrifugal and semi-rotary wing pumps.

Iron Ores of Commerce with Special Reference to Canadian Deposits

By SAMUEL GROVES, Ottawa.

(Continued from Page 359, January issue.)

CARBONATE IRON ORES.

There is a third class of iron ore deposits—the carbonates—which, while generally low grade, have played an important part in the development of the iron trade of the world, for they were among the first to be worked on a comparatively large scale. These ores, however, whilst having a carbonate base, are not homogeneous as regards chemical composition and physical structure, hence commercially, have been divided into three varieties: (1), spathic; (2), clay-ironstone; and (3), black-band ironstone.

Spathic Ore.

This iron-bearing mineral is also known as Chalybite, but more commonly as "siderite." The term "spathic" is derived from the German, and means sparry, since it is often found in granular masses, with glittering spar-like cleavages on the fractured surfaces, and frequently occurs as small, well developed, brown, rhombohedral-shaped crystals. When pure, siderite ($FeCO_3$) has an iron content of 48.2 per cent, is usually high in manganese, and contains some 2 per cent of moisture, in this respect differing greatly from "Limonite," which contains at least 8 per cent, and may contain as much as 15 per cent, or even more.

The siderite ores are indigeneous to the Devonian rocks, occurring in lode formation, *i.e.*, in crevices and fissures. They evidently originated about the time when the first vertebrate animals, with their cartilagineous bony structure, were coming on the scene. The limited amount of phosphate of lime in the decayed anatomy of the myriads of these old fishes, etc., may account for the fact that the carbonates contain only traces of phosphorus.

Where outcropping, siderite is very susceptible to atmospheric agencies, hence, due to oxidation and hydration, is frequently transformed into limonite, to a depth of 3 feet or more. Moreover, by this natural process of oxidation, iron and manganese—both common to siderite—are separated. The ore resulting from these oxidation processes is generally gelatinous, amorphous limonite on the one hand, and amorphous manganese on the other. It is in these amorphous masses that crystalline limonite and kidney shaped hematite are found in the cavities and crevices of the rocks often side by side. It has been ascertained that siderite changes to limonite, and sometimes to hematite, when there is a diminution in volume to the extent of 19.5 per cent, but the precise cause of this differentiation has not yet been determined.

The susceptibility of siderite to weathering is of vital importance to prospectors and mining engineers; for cases are on record where extensive outcrops of siderite have been changed to limonite, to a depth of 30 feet or more. There is a danger, therefore, of outcropping lode deposits of limonite being only "skin deep," and hence of being overestimated as regards the iron content of the deposit as a whole.

As a rule, siderite deposits are represented, on the surface, by limonite, which is sometimes mistaken for hematite, on account of the reddish colour of the gossan, which is not due to hematite, but to red hydrate.

When roasted—in order to eliminate most of 38% of carbon dioxide (CO_2) and other volatile constituents, and to expel the 2% of moisture which siderite generally contains—the ore is rendered more economical for reduction in the blast furnace than limonite—which often contains from 8 to 15% of moisture—and is transformed into a close approximation to hematite, as regards iron content.

Experience has shown that spathic ores, after roasting, yield a good quality of iron, particularly suitable for steel making on account of their low phosphoric content. Prior to the discovery of the great beds of hematite, siderite ores were in great demand.

Although siderite deposits are not extensive in Great Britain—where they have been mined for centuries at Weardale in Durham and in Cornwall North Devon and Somersetshire—but they occur extensively in central Europe, notably in the Seigerland and Zips—Cormorer districts of Westphalia, Germany, and upper Austria. The siderite ores of Westphalia will once again become important, seeing that Germany has been deprived of the enormous and immensely profitable Minette ore deposits of Lorraine.

The siderite lodes in the last-named industrial regions have a dip of 60° to 90°, and are found as large grouped fillings, in simple fissures of the country rock. The width of some of these lodes is said to be as great as 60 feet, with a depth of 1300 to 1900 feet.

In Canada, at the present time, a large portion of the meagre iron ore produced, is **siderite**, obtained mostly from the Magpie mine, situated in the Algoma district, in the vicinity of Michipicoten harbour, on Lake Superior. The "Magpie" is the largest iron ore producing mine in the Dominion. The deposit was originally staked out in 1909, as a prospective source of magnetite; it was soon found, however, by practical mining, that the showing of magnetite was only superficial, the underlying mass proving to be essentially hard, dense fine-grained **siderite**—having an iron content of about 35%, in which the colour varies from pale yellow, though grey to black, according to the amount of metamorphised magnetite present. With a view to commercializing the product, a modern rotary roasting kiln was installed, 1914, in order to eliminate the moisture, but more particularly, the objectionable sulphur.

Tests of the raw ore, in 1919, showed an iron content of 34·3 per cent, while the roasted ore evidenced 50 per cent. The following is a detailed analysis of the roasted ore:

Iron	50·10	per cent
Silica	9·14	"
Sulphur	0·136	"
Phosphorus	0·013	"
Alumina	1·28	"
Lime	7·96	"
Magnesia	8.04	"
Manganese	2.74	"
Loss by ignition	None	

Geologically, the deposits are reported as standing almost vertically between Keewatin rocks, the direction of the lodes being, generally, east to west, with greenstone on the north, and quartz-porphyry schist on the south.

The mining operations are conducted by means of back stoping from sub-levels, with air, water, and power systems on modern lines. All the ore mined passes though the up-to-date roasting plant.

The output of the roasting plant in 1919, was 189,962 tons—which has been about the average production since 1915. When it is stated that the total iron ore shipped from the mines of Canada in 1920 was only 120,000 tons (the lowest in 20 years), the national importance of the Magpie mine will be manifest. And since explorers of the iron-bearing district of northern Quebec declare that siderite abounds, the successful treatment of like ores in southwestern Ontario may be looked upon as a valuable school of experience, worthy of emulation.

Clay Ironstone.

It is a safe generalization to affirm that clay ironstone is to be found associated with the coal-measures of nearly all coal basins: a provision in nature which has made greatly for commercial progress. Our crude commercial appliances of the past, for the smelting of iron ores on a large scale, would, without coal, have been practically useless.

In the middle of the nineteenth century, clay ironstone was in almost universal use in England, and even at the present time is mined more extensively than any other iron ore in Great Britain. This preponderating use of clay-ironstone, was not due to its intrinsic worth as an iron-bearing mineral, for it is the poorest and most impure of all the ores which have been smelted and practically worked, but was due to its close juxtaposition to the coal-fields of Staffordshire, Yorkshire, Derbyshire, Durham and South Wales. An historical parellel is found in the U. S. A., where, prior to 1890, the poor carbonate ores of Pennsylvania were almost exclusively used, because of their close proximity to the coal-fields. Another parallel case is Germany, where, previous to 1870, the clay-ironstone of Westphalia, was the chief iron ore mined; for poor though it was, it paid to use it, because found in abundance near the Coal-measures of that region, which has since become headquarters of the German iron and steel trade—with Essen as its centre. All the great iron and steel industries of the world are contiguous to some important coal-field.

The iron content of clay-ironstone averages about 30% generally in ferrous carbonate form, and is associated with some of clayey material, hence the mineral is sometimes designated as argillaceous iron ore. The deposits often occur in nodular masses, in clayey and shaley rocks, occasionally lying immediately on the coal seam, where the ironstone and coal along the strike or dip sometimes merge into each other. The ore is remarkably free from earthy impurities and animal remains and presents a hard stoney structure, varying in colour from light brown to dark grey. The grey changes to brown upon exposure to the air—due to oxidation, and some of the superficial carbonate is converted to sesquioxide. The fact that ferrous carbonate predominates, is evidence that precipitation took place in solutions poor in oxygen, which was probably due to the abstraction of oxygen by the myriads of organisms present in the metalliferous solutions. Inasmuch as the deposits are often conformable over large areas in close association with coal seams, leads to the induction that they were precipitated in shallow water, a view that is confirmed by scrutiny of the physical structure of the ore. The proportion of silica to alumina is said to be fairly constant—about 2 to 1.

While the clay-ironstone deposits are near the true coal beds, they are never in them. When iron is found intimately associated with coal, it generally exists as bisulphide of iron pyrites, having the appearance of golden-yellow crystals. This "brassy" excresence is often mistaken for gold by amateur prospectors.

The largest clay-ironstone deposit in Britain is found in the Eston hills in the Cleveland district of north-east Yorkshire, where it occurs above the Coal-measures, in rocks of much later date than the Carboniferous, i.e., the Middle Lias, and is divided by bands of shale and pyrites. The main seam at Eston is some 20 feet thick, yielding as much as 50,000 tons per acre. The ore in many of the strata has a nucleus in which are found the remains of fish, crustaceans,shells, and plants, the structure of which contain phosphoric acid, accounting—to some extent—for the high phosphorus content, which is as much as 3·87 per cent. The principal seam of this immense deposit—which runs for 20 miles in the hills overlooking the Tees valley, and terminating in the high cliffs that guard the Yorkshire coast—was discovered by John Vaughan, in 1850; an incident that led to the founding of the celebrated firm of Bolckow, Vaughan & Co., at whose Eston steel works, the epoch-making basic process, invented by Thomas and Gilchrist, was first tried on a commercial scale, and which gave the company, in the early 80's of the nineteenth century, a practical monopoly of the steel rail trade of the world. These Cleveland ores have an iron content of 33 per cent, with 0.75 per cent of phosphorus, and considerable self-fluxing calcium and magnesia carbonates. The pig-iron produced contains as much as 1.6 per cent of phosphorus hence is unsuitable for machinery castings, but is used extensively in the manufacture of cast-iron water and gas pipes, owing to the non-oxidizing properties of high phosphorus iron. This preservative property of phosphoric iron is the open secret of the industrial phenomenon that the localities in all countries where highly phosphoric carbonate iron-ores abound—Yorkshire, Derbyshire, and Staffordshire, in England, Pennsylvania and Alabama, in the United States, and Westphalia, in Germany—are important centres of the pipe-founding industry.

The fact that certain clay-ironstones of Staffordshire, England, contain only 0.25 per cent of phosphorus, gave them a considerable reputation in the days prior to the discovery of high-grade, low phosphorus hematite ores, for the pig-iron produced therefrom, was utilized very largely in the making of wrought iron, by the puddling process. This product was advantageously used in the manufacture of hand-made chain, an article of commerce for which the "Black Country" of England has always been famous.

In 1865, Germany mined 1,154,000 tons of clay-ironstone, in Westphalia, but since 1906, the working of these low-grade ores has practically ceased. Seeing, however, that the Minette ore lands of Lorraine have been restored to France, and Germany is thus deprived of her greatest source of iron ore supply, it is more than likely that there will be a revival in clay-ironstone mining in the Westphalia region.

Necessity is the mother of invention, and the possibilities of the development of the electrothermic process for the utilization of low-grade ores, and the production of high-grade iron therefrom, are boundless.

In recent years, British Columbia, Canada, has become an important coal-producing region, and, reasoning from analogy, should be a producer of clay-ironstone also. As already pointed out (p. 55) in all countries where coal is found, as for example in Durham, England, Westphalia, Germany; and Pennsylvania, U.S.A., clay-ironstone is found in close juxtaposition to the coal-fields, and the districts mentioned have become important manufacturing centres. The occurrence of clay-ironstone in association with the Coal-measures of Vancouver Island, and the Queen Charlotte Islands, has been authoritatively reported,* accompanied by the following comment: "but in the undeveloped condition of these properties, it is impossible to form any idea of the quantity that might ultimately become available."

One of the remarkable object lessons in industrial progress has been the fact that, the highest degree of development, and the greatest achievements in metallurgical science have been accomplished in regions where fuel and flux were found side by side with ore deposits meagre in iron and vitiated with earthy impurities, such as the clay-ironstones.

Blackband Ironstone.

In chemical composition, the blackband ironstone is similar to the richer spathic and clay-ironstone carbonate ores, plus 15 to 25 per cent of bituminous or carbonaceous matter resembling cannel coal, which renders it self-calcining. After calcination, the residue contains 50 to 70 per cent of metallic iron. The best variety has a specific gravity of 2.8 to 3, and hardness of 3 to 4. It is named "blackband" because of its black colour and stratified structure.

Geologically, blackband ironstone occurs in most of the coal-measures of Scotland, England, South Wales, Western Pennsylvania, U.S.A., and Westphalia, Germany, generally associated with the lean coal. The intermixture of clay-ironstone and coaly matter is not due to deposition of ironstone in the coal, but said to be due to the filling in of carbonaceous material into the pores of the ironstone rock. In Scotland, the seams in the Upper Coal-measures are as much as 4 feet thick, whereas those of the Lower Coal-measures are only 2 feet thick. In all the deposits the seams are very irregular in strike and dip, and vary greatly in thickness. Oftentimes where a fault in the ironstone occurs, the other side of the fault will continue as a coal seam. Moreover, they are seldom horizontal, being more or less steeply inclined, due to tectonic disturbance.

The economic value of the blackband ironstone was discovered by Mushet in Lanarkshire, Scotland, in 1801, but the ores were not worked until 1831.

The deposits in North Staffordshire, England, are rich in manganese, and after calcination are used economically as "fettling" for puddling furnaces. The traffic in this commodity, however, has fallen off very considerably, due largely to the increasing substitution of mild steel, for wrought iron, which has, practically, put the puddling furnace out of business.

Although enormous deposits[1] of blackband ironstone exist in the countries already mentioned, the erratic disposition of the ore in the earth renders working so difficult, and cost so high, that at the present time, with the exception of Scotland, mining of these ores for metallurgical purposes has practically ceased, Germany is the only country where—consequent upon international readjustment of territory—the resumption of the mining of these carbonate ores on a large scale is likely to take place. The discovery, since the days of Mushet, of immense deposits of rich hematite and magnetite ores in easily accessible parts of the world, has made it uneconomic to use low-grade ores, hence the passing of blackband ironstone as a commercial commodity.

A table by Longmuir,[2] giving approximate chemical analyses of the various ores embraced in the

*Iron ore occurrences in Canada, Vol. I, p. 6 (Mines Branch, Department of Mines, Ottawa, 1917.)

[1] Scottish reserves estimated at 8,000,000,000 tons. English 12,500,000,000 tons.

Approximate Chemical Analyses of the Iron Ores of Commerce.
The Different Iron Ores.

Constituents.	Swedish Magnetite.	Red Hematite (Cumberland).	Brown Hematite.	Spathic Carbonate.	Clay-Ironstone.	Blackband Ironstone.
Ferric oxide (Fe_2O_3)	66.00	73.00	70.00	.....	.....	2.72
Ferrous oxide (FeO)	23.00	.....	.....	54.80	36.30	40.77
Manganous oxide (MnO)	1.50	0.70	0.80	1.34	1.68	.....
Carbon dioxide (CO_2)	.....	0.80	3.00	38.50	31.20	26.41
Alumina (Al_2O_3)	3.00	6.50	3.50	1.04	4.64	.....
Silica (SiO_2)	5.04	9.50	10.50	1.00	7.95	10.10
Magnesia (MgO)	1.20	0.02	1.34	.....	1.07	0.72
Lime (CaO)	0.23	1.00	2.50	3.26	8.68	0.90
Phosphoric acid (P_2O_5)	0.01	0.03	0.02	0.04	0.72	0.60
Sulphuric acid (SO_3)	.....	0.43	8.30	.....	.....	.....
Water (H_2O)	.....	8.43	8.30	.....	.....	.....
Organic matter						

[illegible] may serve as a comparative [illegible].

(Conclusion.)

In preparing this treatise on the iron ores of commerce, in the interests of the student of "applied" metallurgy, the limitations of space necessitated the omission of some ores of minor importance, such as those containing manganese, titanium, chromium, etc., all of which may have a comparatively high metallic "iron" content, but which are not mined for the iron they contain, but for their particular alloying property. For example, manganiferous ores are valued, specifically, for the manganese they contain, which is chiefly utilized as a toughening alloy in the manufacture of special steels and bronzes, hence, these and like alloying ores, are not classified under the designation of "iron" ores of commerce, although playing a prominent part in the iron and steel industry.

Moreover, newspapers and trade journals are constantly announcing the discovery of wonderful iron ore deposits in Madagascar, South Africa, New Zealand, India, and other countries, and this is not astonishing, when we realize the important part iron plays in modern civilization, and the keen struggle there is between the nations for control of iron ore deposits and for supremacy in the manufacture of iron products. So prolific are these announcements, that my review could have been padded extensively with graphic recitals of these interesting discoveries. The temptation, however, has been resisted, and the panoramic views set before the reader, have been confined—with the exception of northern Quebec—to commercial iron ores, which are being conveyed, every hour, over the seven seas and over the great highways of the world, to the roasting plants and to the smelting furnaces in important industrial centres.

(Concluded.)

[2] Elementary Practical Metallurgy of Iron and Steel, by Percy Longmuir, 1905, p. 44.

A 300-TON ELECTRIC SHOVEL IN OPEN-CUT QUARRYING.

Employment in Michigan Limestone Quarries.

The "General Electric Review" for December 1920 contains a description by C. R. Fisher, Electrical Engineer of the Michigan Limestone & Chemical Company, and H. G. Head of the General Electric Company of Detroit describing the design and application of electric shovels of unusually large capacity to open-cut quarrying.

Mr. Carl D. Bradley, the President & General Manager of the Michigan Limestone & Chemical Company contributes the following statement to the "Review" regarding the evolution of the idea of using large-scale electrical shovels.

"About ten years ago the Michigan Limestone & Chemical Company purchased a tract of several thousand acres extending for several miles along the shore of Lake Huron and containing limestone which the company intended to develop commercially for blast furnaces, chemical plants, etc. The limestone lay close to the water front and delivery to steamers was comparatively easy and economical with proper facilities.

In order to establish a market for its product the company made sales contracts at very low prices which required very careful consideration of all details relating to construction and operation of the plant in order that costs might be kept within the limits prescribed by the selling prices obtainable. Large scale operations were involved and many engineering problems had to be solved. The general problem was to drill, blast, quarry and transport the stone to the mill and there crush, size, wash and convey it to storage, and thence load it into steamers.

Changes were necessarily made in the plant from year to year, and the difficulty of handling the great tonnage was finally overcome by the installation of large crushers, large screens and similar equipment. The loading facilities have developed to a point where steamers of 13,000 gross tons are loaded in six hours, and the management is convinced that theoretically the problem of quarrying the limestone is no different from that of handling and loading it. However, no adequate means of geting large output from open cut quarry operations at low cost had been developed, and therefore attention has lately been forced upon production at the quarry.

Quarrying operations are being conducted against the natural bluff of limestone which is now in excess of one and one-half miles long and more than one hundred feet high, requiring two benches. This bank is too high for the economic and safe operation of the 100-ton steam shovel, and because of this fact and the high costs of labor and material the management has become deeply interested in the application of large digging and transportation units which will permit the quarrying operation to keep pace with the mill and loading system. If a digging machine can be had which will take care of 5000 tons of material in ten hours and operate satisfactorily under this punishment tion, with a resultant economy in all operations.

day in and day out, the problem is approaching solu-

For the future the quarry will approximate two miles in length in one face with five large electric shovel units working against it, served by locomotives and cars of comparable capacity. One man will operate the shovel and another the train, and the tonnage per man hour will be multiplied by five over that of present day equipment. With the introduction of the 300-ton electric shovels, quarrying on a large property such as that under consideration is reduced to a scientific basis.

The modern trend in industrial development has been toward increasing the efficiency of the individual, or in other words, the rate of commodity handling per man hour; only by such a test have we the right to measure accomplishment. While the management has been able to satisfactorily increase the rate in crushing limestone, in screening, conveying and loading it, until recently efficiency at the digging end has not kept pace with that of other operations, and it was specifically for the purpose of improving this performance that the 300-ton electric shovel was installed. The results that have been accomplished by the new equipment have been most gratifying, and it is firmly believed that through the proper application of these large electric shovels the quarry operations will be made entirely satisfactory."

The shovel described is a model 300 E. Marion electric shovel, fitted with 80 ft. boom, to give a digging radius of approximately 54 ft. at the rail, and 99 ft. at 40 ft. above the rail. The dipper now being used has a capacity of six cubic yards, but ultimately a capacity of eight cubic yards is proposed for the dipper. A detailed description of the electric drive and control, and figures of performance and cost is given, and the aritcle is well worth consulting by those who have large-scale digging operations in charge.

BOOK REVIEW.

COAL IRON AND WAR.—A Study in Industrialism Past and Future. By Edwin C. Eckel. 8 by 5½ inches. Cloth Boards. 375 pp. with Index. Henry Holt & Co., New York.

Major Eckel is a well-known authority on the iron ores of the American continent and Newfoundland, and while his most recent work is addressed to the people of the United States, it is noteworthy for a consistent fairness towards the peoples and the achievements of the British Empire, and in its numerous references to Canada and Newfoundland.

While the title of the work intimates strong stressing of the importance of coal and iron in international relations, and an all too rare appreciation of their bearing upon the balance of national power and the migration of industry, the author reviews also the world influences of petroleum, natural gas, and water power; the precious metals, commercial metals; and chemical and industrial materials. In regard to gold, Mr. Eckel shows by graphs of index numbers, population, and gold production, that there is much to be said against the traditional views of economists regarding the tendency of increased gold output to raise commodity prices. An interesting statement is that at the date of the discovery of America the entire gold possession of all Europe was only one hundred million dollars worth of gold in any form, or less than one-quarter the annual gold production of the world at this time. The tremendous increase of gold production commencing about 1885 coincided with the lowest prices of the century.

Mr. Eckel emphasises the great lead that Britain had in the industrial revolution that followed the application of steam power, and proves that this revolution reached different countries at different periods, that it is not necessarily a slow process—to emphasise which he instances Japan,—and that it is not dependent on the genius of any particular people, but is rather conditioned by possession of the essential materials. He views the effect of tariffs as nugatory in the long run, and calls the embargo on foreign imports, "that most futile of political expedients." Mr. Eckel's views on tariff questions are refreshing, and what one might expect from a writer who sees that invention and discovery and possession of the essential materials will always outrank legislative attempts at controlling the evolution of industrialism. To discussions on the tariff and resulting literature he credits the vast growth of the paper industry in the United States—something in regard to which Canada is not entirely guiltless. To the existence, and unequal distribution of coal and iron ore over the earth, and to the concentration of industrial development in favored regions which has resulted, the author credits the repeated charging of the balance of power in the world, effects which he states are not yet finished.

Petroleum does not, Mr. Eckel believes, provide any permanent substitute for coal. "Our children will in all probability see the end of the petroleum industry." His remarks on Canada in this connection were made before the discovery of oil in the Arctic Circle.

The calculations on iron ore reserves are of much interest to Canadian readers, inasmuch as Mr. Eckel allows a life of 45 years, at annual shipments of 55 million tons, to the ores of the Lake Superior region. He states that every year sees a fall of about one-half of one per cent in the metallic content of the iron ore used in the Northern United States, wherein there is conveyed a palpable hint regarding the leaner ores of the Lake Superior region that lie in Canadian territory.

The duration of the iron-ore deposit of Wabana, Newfoundland, at present shipment rates of one million tons annually is placed at 4,000 years, only approached by Cuba, which, at an annual shipment rate of two million tons, is given a life of 1,500 years. The iron-ore beds of Newfoundland are stated to be true sedimentary beds, and Mr. Eckel criticises as "one of the most persistent of scientific stupidities" that theory of their origin by replacement from the surface, wrongly applied to the ores of Lorraine, and also to those of Wabana and Alabama. In each case, states Mr. Eckel, this opinion has cost a lot of money, "and in the case of Lorraine it has cost a war."

The concluding chapter of "The Future of World Competition" appraises very fairly the charged position of Britain arising from her dwindling fuel supply, but states that "in the Dominions and the colonies " overseas there lie the means for renewing the as- " cendancy of the Empire as a whole. It is overlook- " ed, by those who think only in terms of acreage and " population, that in Canada and in Australia there " are very large coal supplies, very accessible for " water shipment, while in South Africa and India " there are large but important deposits... Eastern " Canada will come day become one of the great steel " exporters of the world..."

As the possessor of the greatest coal resources in the Empire, the coming industrial importance of Canada is very plain to those who read history in terms of coal and iron.

With regard to the East, Mr. Eckel does not fear Japan as an industrial competitor, because of that country's lack of coal and iron, but with regard to China, his view is summed up in the statement that the Hangyang steel works, could even now, "if they had any surplus for export, lay down finished steel " products in San Francisco more cheaply than could " any American steel works." Mr. Eckel sees no reason why the growth of Chinese industrialism should not be concentrated into ten years, and he intimates his belief that "the chief industrial features of the " next two or three decades may easily be the growth " of Chinese industrialism."

In his last chapter the author discusses the possibility of future wars which he considers will arise from unequal national distribution of important natural resources.

We consider Mr. Eckel's book to be a most important one, and worth the perusal of persons interested in mining in Canada. The character of the work merits a review of unusual length. F. W. G.

BLOW HOLES IN CASTINGS.

Before a meeting of the Institution of British Foundrymen held at Sheffield recently, Dr. Desch gave a scientific explanation of the causes of blow-holes in castings as they were conceived by a metallurgist, Dr. Desch stated that his actual experience in the making of castings was not large, but that any addition which the metallurgist could bring to the experience of the foundryman would be of value in finding out how to avoid blow-holes in actual practice.

First of all there were the cases where blow-holes were caused by the trapping of air as the metal fell into the mould. He did not know how far those cases presented themselves in steel castings, but in the case of iron they certainly did occur. The trapping of air might take place in the making of small castings when the mould was being fed from a gate. This was a more frequent cause than was generally supposed in the making of iron castings. It was often due to mechanical causes that they had blow-holes. Some were due to defects in the moulds due to the use of sand in a composition which was too wet, or to the presence of wet patches or to blowing cores. A good deal of trouble was caused through cores blowing, and it was difficult to remedy them without altering the whole design of the casting. All these causes could be overcome by care in the moulding and in the preparation of the mould. What he wished to speak of more particularly was the subject of blow-holes due to gases which had originally been dissolved in the mould and then set free in the freezing. That class of blow-holes seemed to him to be more interesting than the others, because their causes were rather more obscure. In the class of blow-holes which they first had, they could be remedied by care in moulding, but in the class of blow-holes caused by gases they were dealing with something that occurred in the steel. When defects of this kind did occur there was liable to be discussion between the manager responsible for the moulding of the castings and the man responsible for the making of the steel. It was just as well to look into the possible causes to see who was more likely to be responsible. They must look into the way that gases dissolved in molten metal, becauses owing to the peculiar behaviour of those gases conditions arose which gave rise to the formation of blow-holes when they might not otherwise be expected. They all got their idea of the behaviour of liquids towards gases by their experience of water. If they heated up water to boiling point they knew that it gave off a quantity of fine bubbles, but work that had been done showed that in this respect it was water that was abnormal and not the metals. Nearly all gases dissolved in liquids more readily as the temperature rose. Water was the exception, as it dissolved less gas as the temperature rose. Gas would dissolve both in liquid and solid metals and in both cases the solubility increased as the temperature rose. Liquid metal dissolved very much more gas than did the solid metal. In all liquids there was a comparatively gradual increase of solubility, but when they were cooled down to freezing point the quantity of gas they could hold was decreased very rapidly. After it became solid a smaller quantity still remained.

The speaker went on to illustrate his point by giving examples of tests that had been made. Copper to the weight of 2¼ lbs. was heated in contact with sulphurous acid, and then allowed to cool. At freezing that copper would give out 1,430 cub. cent. of gas. If the gas were hydrogen and the metal copper, the gas would only be about one-hundredth part of that. Iron would give off 130 cub. cent. of hydrogen. They could, therefore, see what might happen in some other cases. Taking the case of silver he said that when it was melted it absorbed oxygen very rapidly. When silver was being melted and cast into the ignot they would see that a cover was put on the top to prevent it from spitting. They would see the top of the ingot rising at one stage when the metal was nearly solid and a workman beat down the top. If he struck too soon he would find the liquid metal spring up into the air. That was the release of the oxygen. If they examined blow-holes in castings not caused by the action of steam or air they would find inside the blow-hole no sign of oxidation. Hydrogen and carbon monoxide were the two gases usually present. When the metal began to freeze they had crystallisation which began from the side of the mould. These crystallites contained a small quantity of hydrogen and carbon monoxide. The rest of the gas had to be given off or absorbed in the process of freezing. If there was a way out it would rise and come out at the top of the mould. If it did not come out, bubbles of gas might be trapped between the growing crystallites, and in that gas they had blow-holes. Each of the bubbles of gas that remained was a blowhole. The gas could not be held in solution and it could not escape.

Discussing the influence of pressure, Dr. Desch said that if they increased the pressure of gas which was in contact with the liquid the liquid dissolved more of the gas under higher pressure. One knew that very well in the case of aerated water. Carbonic-acid gas if pumped into water by applying high pressure was dissolved. It was impossible to see the gas in a full bottle of soda-water. If the pressure was released by taking out the stopper the gas came out. By doubling the pressure they doubled the quantity of gas that could be held. In the case of metals that did not hold, the amount of gas that could be dissolved was proportional not to the pressure, but to the square root of the pressure. Although the change with pressure was not so great as with water and carbonic-acid gas there was a change in that direction, and that was why some of the blow-holes were trapped in the lower part of the ingot before the whole was solid. It might well be that after freezing had taken place higher up there might be quite considerable internal pressure, and in that case gas, although present, might not come out of the solution. In that case they might fail to get blowholes, although the quantity of gas was large enough to cause blow-holes had the pressure been low. In the upper part of the casting they might get blow-holes provided the gas was not able to escape through the head. Mr. Brearley, in his experiments with wax ingots, had clearly illustrated this.

Discussing the blow-holes that occurred in the furnace, Dr. Desch said that in the open-hearth furnace they had gases that contained oxides of carbon, also hydrogen and water vapour—hydrogen coming from the water vapour. There were a series of reactions going on in the bath, and these reactions were not over when the metal was tapped. In these reactions they had carbonic-acid gas reacting with the iron to form carbon monoxide. As long as there were any oxides present in the steel, reactions would go on and they changed with the temperature. The more iron oxide they had the more carbon monoxide there was. Carbon

monoxide was very soluble in the molten steel. Most of the carbon monoxide they had there depended on the amount of oxide in the molten steel. If they took away the oxygen they reduced the quantity of carbon monoxide, and if they gave the metal time the carbon monoxide that had been set free could escape. To get rid of the gas in steel it was essential to remove the oxide. If they got rid of the oxide completely there would be little fear of trouble from gases. The same thing held good very largely in regard to hydrogen. It must not be forgotten that reactions might go on after the deoxidiser had been added. De-oxidisation was not instantaneous. It was not possible, so far as he knew, to kill steel by any instantaneous process. Time was always required. There was the danger that the deoxidisation process might be held up and they might pour the metal into the mould and then the reaction that had been suspended might start again, and there would still be carbon monoxide coming off. One reason for that must be that the giving off of the gas must always be rather slow. They knew that if they took a bottle of soda water and released the pressure on the gas it did not come off instantaneously. It took some time to escape. The skill in making soda water seemed to depend largely on controlling that escape. When water held more gas in solution than corresponded with the temperature and the pressure it was said to be supersaturated. Steel could remain supersaturated with carbon monoxide for some little time. A small quantity of gas in contact with the metal would break up a supersaturated solution.

If they took silver, which would dissolve a very large quantity of oxygen it would give that oxygen out in spitting as it solidified. If they took an alloy of silver and gold they would find that it would dissolve very much less oxygen. As the quantity of gold increased they would find that the quantity of gas evolved decreased until the alloy would not spit at all. They would expect that alloying metals with steel would produce the same result. That was generally the effect though not always the case. Carbon monoxide was more soluble in the liquid steel than carbon di-oxide. As the metals were cooling down the reactions were going on, and it might be that the carbon dioxide coming into contact with the iron might form carbon monoxide. These are merely a few facts connected with the formation of blow-holes. It seemed that the question of solubility of gases in metals mainly affected the formation of blow-holes.

In the discussion that followed, Dr. W. H. Hatfield asked Dr. Desch whether it were not a fact that sound steel, if carefully examined, was found to contain more gas than blown steel. He believed that it was an established fact that if silicon, manganese or aluminum were added under proper conditions it made the steel capable of containing in a solid state the gas which would otherwise come off. Dr. Desch said he agreed that the quantity of gas that could be extracted from solid steel bore no relation to the soundness of the steel. The unsoundness was not caused by the gas dissolved in the solid metal, but by the amount of gas not dissolved. As to the effect of aluminum on the solubility of gas in the solid metal, he had not ventured before to express an opinion on that, but did not think it could greatly increase the solubility.

HEALTH CONDITIONS IN UNITED STATES FOUNDRIES.

The comprehensive study of the health conditions prevailing in the brass and iron foundries of New Jersey and New York, which was begun six months ago by the U. S. Public Health Service, is drawing to a close, with results that are said to be extremely interesting and valuable.

"The Commissioner of Labor of New Jersey," says Surgeon General Cumming, of the Public Health Service, "realizing the need for scientific information on health hazards in the foundry trades, asked the Service some months ago to send specialists to study the trade processes and working conditions obtaining in the brass and iron foundries so that it might advise him wisely in regard to any regulations governing these hazards that might be proposed. His request was seconded by the plant managers, who cooperated enthusiastically in the study.

"In the foundries, as in other branches of industry, the health of the workers is of course of the first important, from both a humane and a business point of view. Ill health causes sickness, absenteeism, accidents and loss of trained men, all of which result in decreased efficiency and reduced output for the plant, causing physical and economic losses to both men and owners.

"The Service gladly accepted the invitation and sent industrial engineers to analyse the plant processes and working conditions and industrial physicians to make physical examinations of the men, thus ascertaining whether working conditions existed that might be expected to react adversely on the health of the workmen and also what physical defects or ailments were actually afflicting the men. Knowledge of these data were of course essential as a basis for an attempt to evaluate the actual occupational heat hazards.

"The chief hazards of foundry work are those associated with production processes, that is of high heat temperatures, which are essential in parts of the plants; of smoke, gas, and fumes, which are evolved in sundry phases of the work; and of dust, liable to be noxious, which is produced abundantly in the sandblast, tumbling, and grinding rooms, where castings are reduced to final form.

"To these hazards are added those due to poor plant architecture, inadequate or unsanitary personal service facilities, and unhygienic conditions resulting from inadequate lighting and lack of attention to cleanliness in workrooms, windows, globes, and similar essentials.

"All of these hazards were studied closely and tentative protective regulations were devised. Chief attention, however, was given to the fumes and the dust, which were believed to be the factors most likely to cause trouble. The investigation made of the sandblast process and its effects was probably the most complete ever made.

"All the data have not yet been assembled; but tentative conclusions indicate that industrial hygiene can no longer be considered merely as a matter of sanitation but must be widened to include fundamental factors associated with plant processes and the materials used therein.

A flattering result of the work has been the cheerful reception by the plants of the recommendations of the Service in regard to the eliminating of the hazards found.

A New Type of Controlling-Valve for Supplying Air and Gas Mixtures to Open-Hearth Furnaces

Secures Proper Mixing of Air and Gas, Resulting in Marked Fuel Economy, and Greater Regenerative Efficiency.

By W. H. WHARTON*

Present day conditions are compelling all industrial plants to give strict attention to the questions of economy and efficiency. More especially does this apply to our large steel plants in which tremendous amounts must be continuously handled and enormous quantities of fuel of various kinds consumed in production and conversion of this material. During the last fifteen years excellent progress along these lines has been made in all steel plants, and while the results achieved might with justification be regarded as very satisfactory, there still remain many directions in which improvements might be accomplished.

There is one branch of our large steel industries which has, from a fuel economy point of view, remained almost at a standstill and is to-day in but a slightly better position than when the open-hearth method of melting steel was first introduced by Siemens and Martin. This fact is the more remarkable in the light of advancement made in almost every other branch of the steel industry.

It is unnecessary to dwell in detail on the almost revolutionary changes that have been made during recent years in the coke-oven and blast-furnace practices, the very importance of which has compelled every steel man to familiarize himself with the details. The methods of rolling and handling large quantities of steel have advanced by leaps and bounds as also have the technical considerations involved in the manufacture and physical treatment of the material until a high state of efficiency and economy has been achieved. and yet, in the midst of all this advancement the fuel economy and efficiency of the open-hearth furnace has practically remained at a standstill. Some advancements have certainly been made in the preparation and production of gaseous fuel, but the actual consumption of these fuels after preparation is as wasteful as ever. This regrettable condition is probably due to several underlying causes. Possibly one of the reasons is that attention has been wholly concentrated on the metallurgical problems of open earth practice and not without excellent results. Possibly the chief reason has been the lack of co-operation between the engineers designing open-hearth furnaces and their accessories, and the open-hearth superintendents and others, in charge of the actual operation of the furnaces, with the result that each has pursued his own course, regardless of, or oblivious to the opinions and ideas of the other.

It is pleasing to note, however, that during the past few years these prejudices have to some extent been overcome, a different attitude being demanded towards this question by the fuel stringency of recent years. As an illustration of this change of attitude, may be cited the recommendation passed at a recent meeting of the Open-Hearth Committee of the Carnegie Steel Company, one of which was to the effect that a furnace should be built apart from the rest with facilities and space to allow of the carrying out of experiments in the improvement of the ports of open-hearth furnaces, the use of removable slag pockets and the volume control of the air-supply. While each of these features demands careful and immediate consideration, it is upon the last that the greatest efforts should be concentrated. Very few of our furnace installations achieve anything near perfect combustion, in fact few exist that are using less than 50% excess air. Some idea of the loss of heat units incurred may be obtained by a brief consideration of this point;

1 lb. of coal forms roughly 4.34 lbs of gas. This amount of gas requires 4.86 lbs of air to form complete combustion.

Heat units (B.T.U.'s) in 1 lb. of coal = 12,500.

Heat Units consumed in heating necessary air to temperature of melting furnace:

$$4.86 \times 3{,}000 \times .25 = 3{,}640 = 29.1\%.$$

Heat Units (B.T.U.'s) consumed when using 50% excess air: $729 \times 3{,}000 \times .25 = 5{,}470 = 43.7\%$, a difference representing a loss of 14.6%.

Now consider this loss in connection with the production of a 50-ton heat of steel. Under moderate furnace conditions, the consumption of coal ranges anywhere from 500 to 700 pounds per ton of steel made. Assume an average of 600 lbs. Therefore the loss on one heat of 50 tons

$$\frac{14.6 \times 600 \times 50}{100} = 4{,}380 \text{ lbs.}$$

Annual loss on each 50 ton furnace producing 16 heats per week:

$$16 \times 52 \times 4{,}380 = 3{,}744{,}160 \text{ lbs.}$$

Now consider the cause of this loss; imperfect combustion, due to inadequate control of the incoming gases, and the use of furnace ports combined with incorrect draft arrangement which prevent, or at least do nothing to assist the proper mixing of the air and the gas.

The usual practice is to deliver the air and gas to one end of the furnace by separate flues, the air flue being directly over the gas flue. This arrangement is adopted with the idea that the difference in specific gravity will cause the mixing of the two. This result might be achieved were it not for the counteracting influences produced by the manner in which the air and the gas are brought to this point.

The gas is delivered from the producers at a pressure of approximately 1" W. G. The delivery of the air is solely dependent upon the amount of the stack draft, which must be maintained sufficiently high to draw the air through the valves checker chambers and flues. This draft pressure continues to exert its influence on both gas and air after the entrance to the furnace is reached, tending to draw them along in a straight line at a high velocity, thus preventing proper mixing. In order to overcome this counteracting influence, it is necessary to deliver the

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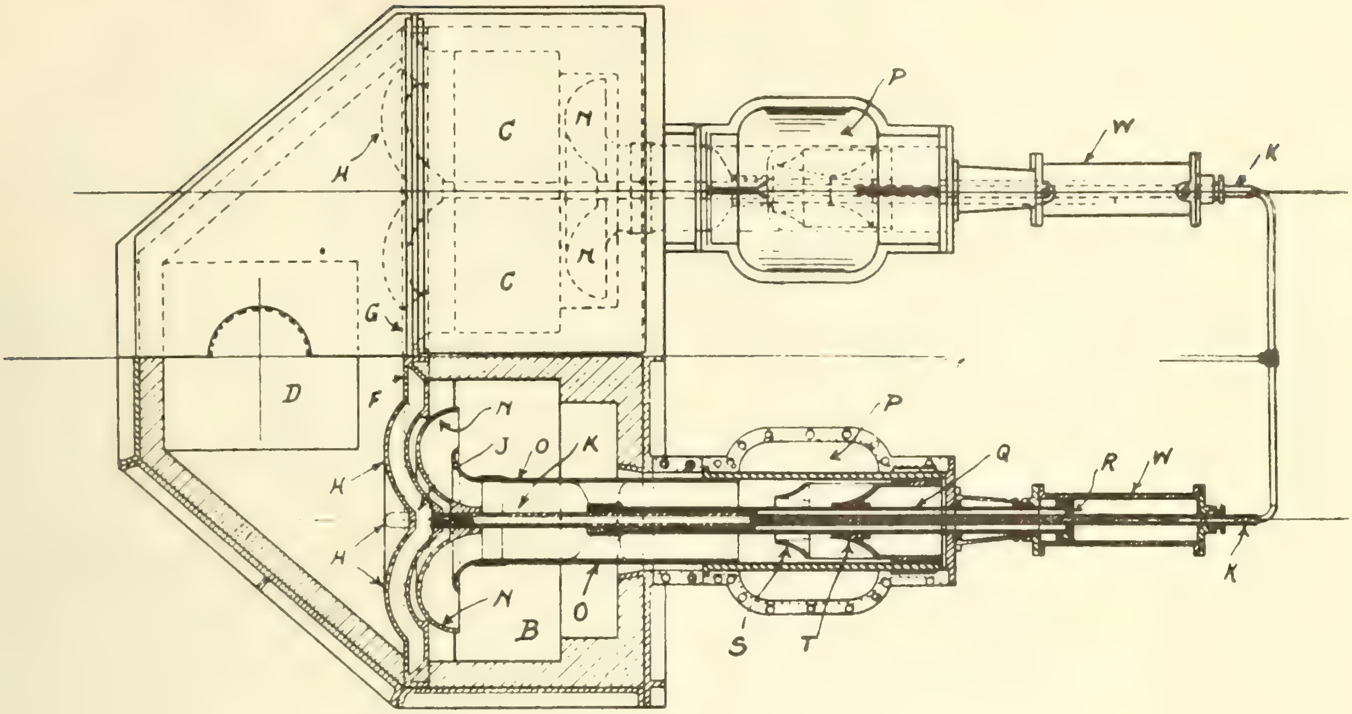


FIGURE "1"

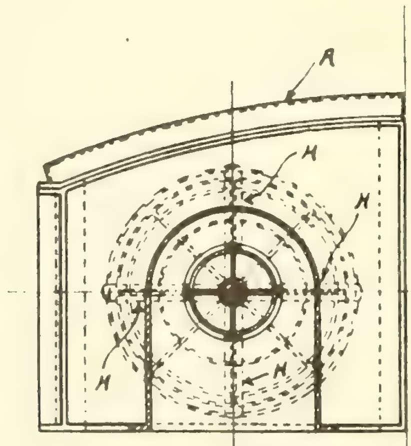


FIGURE "3"

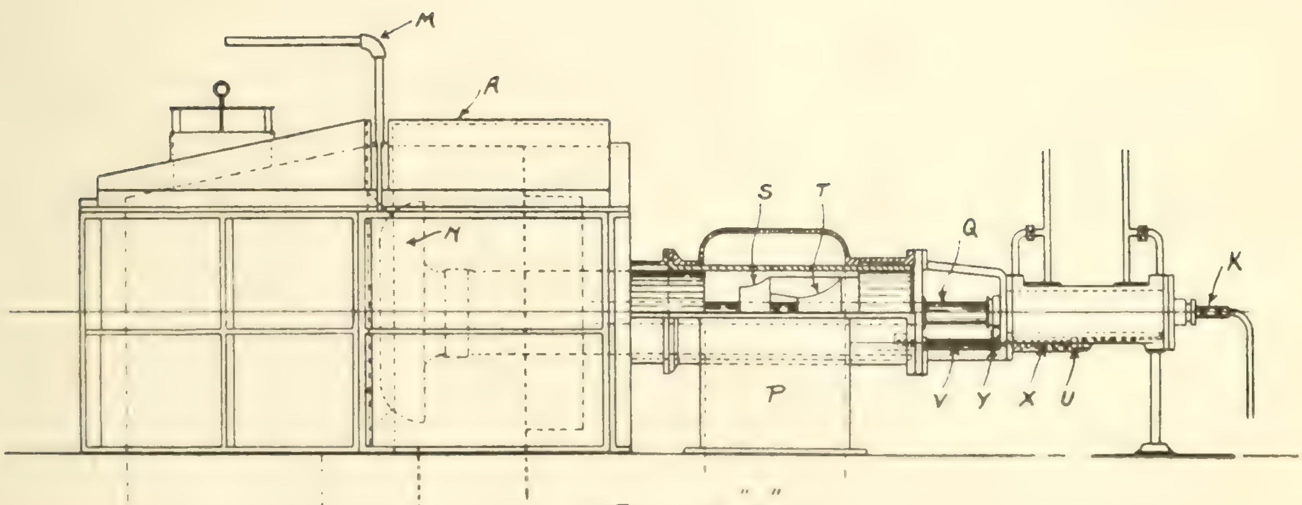


FIGURE "2"

incoming air and gas to the furnace entrance at approximately the same pressure. The draft pressure could then be reduced until there is only sufficient to carry away the waste gases and attain a desirable flame-speed through the furnace. By this arrangement of forcing the air through the checker chambers better regenerating efficiency could be obtained and the present limitations in the design of regenerative chambers removed.

The difficulty of achieving this condition has been overcome by an ingenious arrangement in the form of a reversing valve combined with air-pressure and volume-controlling mechanism, for which applications for patent have recently been filled by W. H. Wharton, Consulting Engineer on steel plant equipment for Canadian Allis-Chalmers, Limited, Toronto.

A description of this valve, the method of operating together with illustration are given below:

Figure 1 is a plan of the complete valve and mechanism, one-half of the plan being shown in horizontal section, the whole plan being symmetrical about the centre line.

Figure 2 is an elevation of same with a portion of the air chamber cover removed, showing the inside of the air chamber and the air-regulating mechanism contained therein.

Figure 3 is an end elevation of half the valve with section through air chamber.

The valve chamber "A" consists of an arrangement of cast plates or other suitable construction, the same being brick lined as to walls and roofing; the whole for the purpose of covering and separating the three different flues "B", "C" and "D", two of which, i. e. "B" and "C" lead in opposite directions to the two regenerative chambers situated one at either end of the furnace, the third flue "D" being connected to the chimney stack. These flues are separated by the partitions "E", "F" and "G", the partition "E" being made of a combination of brickwork and steel. The partitions "F" and "G" are hollow cast-sections filled with water. Each of these partitions "F" and "G" are constructed in such manner as to provide a seat for the valve when closed and to provide an opening for the easy passage of hot gases to the stack when the valve is open. Across this opening, pass four bent, hollow, tubes "H" all meeting in the centre of the opening, forming a hollow boss "J" which supports and connects the hollow shaft "K" to the four connecting tubes or arms "H". This hollow shaft "K" forms the valve stem upon which is supported part of the weight of the valve "N" and upon which the valve moves to and fro as operated. Another function of the hollow shaft "K" is to provide a means of conveying cooling water to the respective partitions "F" and "G" from which the water passes out by means of pipe "M", provided in a suitable location for that purpose.

The valve body "N" is made of cast iron, steel or other suitable material, suitably designed in order to impede the velocity of the air as little as possible, at the same time to offer the maximum surface possible to the cooling influence of the passing air. From the valve body "N" there is an extension tube "O" for the purpose of conveying and conducting the passage of the air chamber "P" through the valve into the respective flues "B" and "C". The tube "O" is connected by a hollow piston rod "Q" to the piston "R" which is operated back and forth in cylinder "W" by air or steam pressure.

The air-regulating device consists of two circular cones or valves "S" and "T" suitably connected and operated by the small piston "U" and connected thereto by the piston rod "V". On this piston rod "V" is fixed an adjusting wheel "Y" for the purpose of adjusting the length of travel of the air-regulating cones "S" and "T".

The operation of the valve is as follows:—

Air is supplied at the required pressure to the air chambers "P". Water supply is connected to the ends of the hollow shfts "K". Air or steam pressure is admitted to opposite ends of the two cylinders "W", causing one of the valve bodies to be pushed forward into its respective valve seat and opening, at the same time admitting the air to the end of the tube "O" from the air chamber "P". At the same time, the pressure is admitted to the small cylinder "X" which operates small piston "U", thus pushing forward the two cones "S" and "T" to the required position, as determined by the setting of the adjustment wheel "Y". The reverse of these different operations is meanwhile taking place on the other valve mechanism.

The exhaust pipes connected to each end of the two cylinders "W" are provided with a suitable cushioning arrangement to prevent shock at the end of each stroke.

FATIGUE AND INEFFICIENCY IN THE IRON AND STEEL INDUSTRIES IN GREAT BRITAIN.

No. 5 of the Reports of the Industrial Fatigue Research Board in Great Britain, from the pen of Dr. H. M. Vernon, Medical Investigator of the Board, has recently been issued, and a summary of his conclusions follows:

In certain districts many of the men employed in the iron and steel industry were, until recently, working 12-hour shifts, whilst in other districts they were on 8-hour shifts, but in the spring of 1919 the longer shifts were almost completely abolished. It was thought to be of interest to determine, so far as possible, the effects of this considerable shortening of hours upon the fatigue experienced by the workers, and upon their output. Such an enquiry necessarily implied frequent comparisons of the relative degrees of efficiency of the plant laid down in different works, for in many cases it was found that the more efficient the plant the less fatigue of the workers employed in running it. In other words, human efficiency was found to be so closely bound up with mechanical efficiency that Dr. Vernon frequently found it impossible to separate them, and to confine himself to the main object of this report, viz., a study of human efficiency and fatigue. In the course of his investigations, he visited a number of iron and steel works in five districts, viz., South Wales and Monmouthshire, Scotland (Lanarkshire and Ayrshire), Lincolnshire (Frodingham), the north-east coast of Yorkshire (in and around Middlesborough), and Sheffield. A few of the works visited were iron works only, and a large number were steel works only, but, the greatest proportion of all were combined iron and steel works.

The following is a summary of Dr. Vernon's general conclusions:—The investigations made in the three main branches of the iron and steel industry, viz., the

production of pig iron, the production of steel, and the rolling of steel, all point to the same conclusions. They show that in each branch there are tremendous variations in the efficiency of the plant employed in different works, and in the efficiency in which human labour is utilised. They show that it takes four to eight times more men to charge blastfurnaces by hand than by machine; that in the most efficient open-hearth furnaces the charges worked per week are two to three times more numerous than in the least efficient, and they suggest that the efficiency in rolling mills varies in similar proportion. Coupled with the differences of mechanical efficiency, we find that the fatigue of the worker often varies in inverse relation. The barrow-men who hand charge blastfurnaces have a very heavy job compared with the men who charge these furnaces mechanically; the steel melters who hand-charge their open-hearth furnaces have about twice as much heavy work as those employed on machine-charged furnaces; whilst the rolling mill men, who have to control the passage of the red hot steel through the mills by hand, must have more than twice as much heavy work as those who control it by machinery.

We have seen that a reduction in the length of shift from 12 hours to 8 hours leads to very little increase of hourly output, either from the blastfurnaces, the open-hearth furnaces, or the rolling mills. Though the men employed were mostly on a piecework basis, and had to suffer a considerable loss of wages when the hours were reduced, they seemed to be unable, of their own initiative, to increase their output by any considerable extent, and thereby to make up for their loss. However, a great improvement of output does appear possible if the employers and the men co-operate thoroughly to that end. An instance has recently been described, in which the interest of the men in their work was stimulated by the formation of a men's society. Lectures relative to steel production were given by workmen and by managers, new methods of working were suggested and discussed, and if, after due trial, they were found to be of practical value, they were permanently adopted. In consequence of these improvements, and of the extra keeness of the men in working the furnaces, the output of the hand-charged furnaces gradually increased to about 70 per cent. above its previous value. This striking result, be it noted, was achieved without any substantial alterations of plant whatever. Moreover, the casting of the steel was so much improved that the net final yield of saleable steel was raised some 30 per cent. above the old level.

Substantial improvements of plant must necessarily depend on the management, and nothing was more striking than to compare the efficiency of the plant employed in various districts of Great Britain. One district was greatly ahead of others in one respect, and another in another. In one district the capacity of the blastfurnaces was only a-fifth as great as in another district—partly, it is true, because of the lack of cooking coal—and none of these small furnaces were mechanically charged, though some of the larger ones in the other district were so charged. It seems probable that if all the iron and steel works in the country adopted the most efficient methods, they could, on an average, improve their output by something between 50 and 100 per cent. In other words, they could enable their employees to earn more in eight-hour shifts than they had previously done in twelve-hour shifts. It is not to be expected that such an improvement of efficiency can be brought about in a few months, or even in a few years. On the other hand, it does seem to be an economic proposition to demolish all the small hand-charged open-hearth furnaces as quickly as possible, and replace them by the large machine-charged furnaces. It would usually pay to replace old-fashioned rolling mill plant with modern machinery, and almost invariably pay to put down more soaking pits, so as to enable the mills to be fed with a continuous supply of ingots. It is suggested that a technical inquiry into these proposed changes by a competent body of practical men is well worth consideration.

A lack of foresight and combination was sometimes apparent. In one district, dotted about in numerous localities with iron works and with steel works, it is very exceptional for the works to be in proximity, so it is impossible for them to send the molten iron direct from the blastfurnaces to the steel furnaces. On the other hand, in other districts it is the rule to run the iron and steel works in combination, and there can be no doubt that this is by far the most efficient method. Then, again, very few works seemed to have laid down their plant in correct proportions. In only one works did the blastfurnaces produce slightly more iron than was required for the steel furnaces, the steel furnaces produce slightly more steel than was required for the rolling mills, and the soaking pits supply sufficient ingots to keep the mills running with practically no delays whatever, other than from unavoidable causes, such as breakdowns of machinery. Yet this system is the ideal one if true efficiency is aimed at, for any surplus production of iron or of steel can easily find a market elsewhere.

To turn to another matter, there is a curious lack of provision for the comfort of the men on the part of some of the employers. The blastfurnace barrow-men are working night and day in the open, shovelling ore and coke into barrows and wheeling the barrows to the furnace hoist, yet at the great majority of iron works they have no cover whatever. Again, in many steel melting shops there were no proper seats provided for the men, and they had to shift as best they could, though they are usually resting for quite half the time they are on duty. At one works, and one works only, the gas producer men were provided with similar shelters, which had in addition a small stove in cold weather. Dr. Vernon never saw shelters provided for iron puddlers, though they badly need them owing to the intermittent character of their work.

In one respect the men are more at fault than the employers. Several important groups of men, such as the steel melters, the iron puddlers, and the crucible steel men, often have to perform such hot and heavy work that they stream with perspiration, and their shirts may get wet through; yet it is the exception, and not the rule, for the men to keep a spare shirt, and change it for their wet shirt before they go home. Some of them, who live a distance from home, may have to stand about a draughty railway station for several minutes before catching their train, and then sit in a draught, and it may be an hour before they get home and have a change. Probably if the employers provided suitable lockers for the men to keep clothing in, they could be induced to alter this habit, and it is to be hoped that in course of time the employers will not only provide lockers, but drying and changing rooms as well, with adequate washing accommodation. In no single works visited was any such accommodation seen, though it is possible that it was overlooked.

It is well known that negligence in changing wet clothes is a potent cause of rheumatism and we saw that the men working at high temperatures, especially the older ones, suffered much more from rheumatism than those who worked at ordinary temperatures. It is true that they were on sick leave from this cause only for about three days a year, on the average, but is probable that they would suffer rhematic pains sufficient to reduce their efficiency materially for periods amounting, in aggregate, to weeks every year, rather than days.

A not infrequent source of fatigue to the men was observed in the unnecessary weight lifting sometimes demanded of them. The hoppers of furnaces were often 2 feet or more above the level of the platform on which coal was resting, and the men had to lift each shovelful this extra height before they could empty it into the hopper, whereas it would have been a perfectly simple matter to raise the height of the platform. A still more striking instance of unnecessary weight lifting was observed in a boiler house, where some of the furnace mouths were only 2½ feet above the level of the floor on which the coal was resting, whilst others were no less than 4½ feet above the floor level. It was obviously a very awkward and difficult job for the stokers to raise their coal this latter height, and at the same time pitch it the right distance into the furnace though here again the coal platform could easily have been raised.

Of the 146 blastfurnaces inspected, only 18 per cent. were mechanically charged. It takes four to eight times more men to charge the furnaces by hand than by machine, and the work of the hand fillers is of a heavy type. The men have to work a long (16-hour) shift every third Sunday, and it was found that their rate of charging during this shift was 8 to 15 per cent. less than on weekdays, when they worked 8-hour shifts. Again, the rate of charging was 16 per cent. less in the summer than in the winter. No evidence of fatigue could be obtained in the men engaged in charging furnaces mechanically, though they were on 12-hour shifts. Reductions in the hours of work of blastfurnace men from 12 to 8 per shift will cause very little increase of output, but data are adduced to show that time-keeping will be improved. In several cases it was found possible to reduce considerably the number of men per shift, as they worked harder.

The hand-charging of 60-ton open-hearth steel furnaces took five to six hours, in spite of the fact that four or more "helpers" were assisting, whilst machine-charging took two hours or less. The number of charges worked per week varied from 6.2 to 7.2 at different works, chiefly owing to differences of fettling and charging times, and to the fact that the number of effective working hours varied from 129 to 150 per week. The speed of working successive charges generally quickened up throughout the week and the time taken was sometimes 12 per cent less at the end of the week than at the beginning. Reduction of hours from 12 to 8 per shift caused the total output to increase 9 per cent at one works, and 2 per cent at another, but the substitution of hot metal for cold metal caused a 30 per cent increase. The output usually showed a seasonal variation, and at one works it was 11 per cent less in the summer than in the winter.

Owing to the steel melters all starting work at the same time on Sunday the furnaces have their first tap at about the same time, and then for several hours there are few, if any, taps. This intermittency disappears towards the middle of the week, but returns at the end of it. The intermittency, besides increasing the fatigue of the melters, renders it difficult to maintain an even supply of ingots to the rolling mills.

The Bessemer process does not necessitate any very heavy work. The crucible steel process necessitates hot and heavy work, but not so much as the production of wrought iron by the puddling process. The puddlers' output was 8 per cent less in summer than in winter.

Delays in the rolling mills usually average one to three hours per shift. They are due chiefly to (a) lack of material, (b) deficient steam pressure, and (c) other causes, such as breakdowns of machinery. At one mill delays from (*a*) and (*b*) average only six minutes per shift, but in most works (a) is much longer, as the supply of soaking pits is inadequate. Reduction of hours from 12 to 8 per shift was not found to lead to any increase of output, but at one works, where delays were investigated and thereby reduced, output rose 16 per cent. At two works the output was 9 to 13 per cent less in summer than in winter, whilst, as a rule, the delays were greater in the summer. Fatigue in the men stoking the boilers supplying a mill was shown by the fact that between 2 p.m. and 6 p.m., and again between midnight and 6 a.m., the steam pressure fell from 70 lb. down to 62 lb.

Sickness records of about 20,000 steel workers for six years were tabulated. On an average, the men lost 6.5 days per year from all causes. The steel melters and pit-men lost 23 per cent more time than the average, the puddlers 20 per cent more, the tin-plate millmen 12 per cent more, and the rolling millmen 8 per cent more. Almost all of these men frequently work at high temperatures; whilst the engine and crane men and the other workers (largely laborers), who usually work at ordinary temperatures and on less heavy work, showed 8 or 9 per cent less sickness than the average. The excess of sickness shown by the puddlers was due entirely to rheumatism and respiratory diseases. This is presumably because of their custom of alternating periods of heavy work with periods of rest or of light work, for the tin-plate millmen, who work almost continuously, showed no excess of sickness from these causes.

During war time (1915-18) the men showed 31 per cent less sickness than in the pre-war period (1913-14). The oldest men (55-69) lost 9.6 days per year during war time, as against 16.9 days in pre-war time, whilst the youngest men (16-29) lost 4.3 and 5.7 days respectively. Records of 1,000 blastfurnacemen were tabulated for a six-year period, and they showed that the younger men lost one to two days more per year from sickness than the steel workers, whilst the older men lost four days more.

Steel workers aged 25-65 showed a 5 per cent lower death rate than all males (occupied and retired). They showed 102 per cent greater mortality from respiratory diseases, but 48 per cent smaller mortality from tuberculosis (mostly phthisis). The steel melters had a 20 per cent greater mortality than all males, but the other men working at high temperatures and the engine and crane men had a smaller mortality. It is probable that all the records yield too low an estimate of death rate owing to withdrawals of some of the less vigorous men. The blastfurnacemen had a considerably higher mortality than the steel workers, presumably because of their greater exposure to the weather.

EDITORIAL

The Utilization of Canadian Iron Ores

While the primary producers of iron and steel are not intensely interested in the utilization of domestic iron ores at this time (with the notable and commendable exception of the Algoma Steel Corporation) and are chiefly worried about the lack of orders, the declining selling-price of steel and the high cost of ore, flux, fuel, transportation and wages, we are emboldened to return to the discussion of the question by reason of a noteworthy exchange of opinion on this question that marked the recent annual meeting of the Canadian Institute of Mining and Metallurgy at Montreal. The discussion was participated in by pioneers of iron-ore mining in Canada, represented by Mr. T. B. Caldwell, who opened iron-ore mines in Ontario as far back as 1880 and has not yet lost his faith in our iron resources; by representatives of the Algoma Steel Corporation, a company that has contributed the most praiseworthy endeavour towards the utilization of domestic ores by beneficiation; by Mr. G. C. Mackenzie, the new Secretary of the Institute, and for some time Secretary of the Munitions Resources Commission, whose experience includes operating experience in using Ontario ores in the blast furnace, and also Nova Scotia ores, and who has had occasion to examine and report on numerous iron-ore deposits in Canada during the war-period, Dr. Stansfield, whose experiments had led him to believe that a new process may be developed, in which by combining the use of low-grade fuels and electric smelting, the practical commercial utilization of domestic ores may be made possible, by Col. Dwight, who is associated with the Hayden Stone beneficiating enterprise at Babbitt — of which particulars are contained in this issue — and with the Dwight Lloyd [illegible] process that is being used there; by Mr. Balmer Neilly, Secretary of the Ontario Mine Operators Association, on record as being convinced that a bounty on iron-ore mining in Canada is a most desirable thing, by Mr. Edwin Ludlow, President of the American Institution of Mining & Metallurgical Engineers, who expressed astonishment at the importation of Pittsburgh steel for the building of steel-ships in Vancouver, and other men equally entitled to express opinions on this question and expect to be listened to.

The brief of the Algoma Steel Corporation, presented to the Tariff Committee of the Cabinet is republished in this issue, and it details endeavours of which this company may be proud, but which, as we have before ventured to comment, have gone singularly unrewarded by public or governmental appreciation in Canada. Indeed the opposition to a bounty on iron-ore in Ontario has been chiefly based on the belief that it would benefit the Algoma Steel Corporation, a wrong-headed viewpoint that it is probably useless to combat, being rooted in prejudice that proceeds from total ignorance of the part that iron-ore production plays in national development.

The most important utterance during this dicussion was that of Colonel Dwight, who said that if it was destrated that Canada had sufficiently large deposits of low-grade ores similar in composition to the taconites of the Lake Superior Region, and could work out the difficulties of assemblage and transportation, the remaining part of the problem, namely, that of beneficiation, was already solved, and the process was worked out and waiting for this country to avail itself thereof. This was exact confirmation of the conclusion expressed in our last issue, namely that apart from the question of bounties, "there is a field of investigation of processes, such as is being undertaken by the United States Bureau of Mines, which our governments would do very well to enter and enlarge by generous appropriations and definite encouragemnt."

Mr. T. B. Caldwell expressed himself as despairing of government aid through bounties, and suggested an appropriation for study of the iron-ore deposits in Canada, in the field by drillings and in the laboratory, by research work.

At least our governments could take cognisance of the pioneering work being done at Babbitt, and could consult with its technical officers and the representatives of the steel industry as to what extent similar investigations are possible in Canada.

There is no raw material that is so relative in its value in regard to location and quality as iron ore. Some of our Canadian deposits would be hailed as veritable riches were they situated, for example, in the Midlands District of England, but alongside the available supply of Lake ores their economic value is terribly depreciated. As Mr. James McEvoy stated in regard to the coals of the West, some are of greater intrinsic value after paying freight for a thouand miles than others are at the pitmouth itself, and the "thousand-

mile ride" of Lake ores is a standing example of this relative value of iron ore.

The question, we fear is not an economic one. It is altogether a national one, and it is from the point of national self-sufficiency alone that the governments should be asked for assistance. The matter boils itself down to this question. Is the iron and steel industry of Canada to continue and to grow as an extension of the coalfields and iron-ore deposits of the United States, with all that this condition connotes; or is the government at Ottawa, and the provincial governments, justified in encouraging, by state subsidies based on reasons of national self-defence and economic self-sufficiency, the domestic mining of iron ores?

The governments, as the expressions of national will, and as the guardians of the national security, are primarily concerned in this question, which we would restate, is based on national urgency and not on commercial exigencies.

Our relations with the United States are so friendly as to obliterate the demarcation of frontier in trade interchange. The record of the past century, and the outlook for the future, contains no serious suggestion that they can become otherwise than friendly, and no more illuminating example of this friendliness could be adduced than the discussion of the Canadian Institute of M. & M. on which these comments are based. Nevertheless, the desire of Canadians to make iron and steel from domestic ores was taken as granted by the speakers from the United States who participated in this debate, and, to put the matter frankly, this country will be subjected to criticism in the United States *if we do not develop our resources*, but never if we do. The roots of international friction will never proceed from any attempt Canada makes to become self-supporting, but there are some quite obvious sources of friction that originate in our continuing to rest content with national insufficiency and economic dependency.

The whole question is not one that the people of this country should urge upon its governments, but it is one that the governments should urge upon the people, if they desire to see the persistence of independent governments in Canada.

THE SCIENTIFIC SELECTION OF MEN.

In recent years much literature of a popular character has been circulated regarding the selection of men for employment by character analysis, facial conformation and other physical stigmata. Employment managers and industrial executives have been importuned by magazine advertisements to acquire, by correspondence lessons, ability to pick the most suitable person for a selected position out of a crowd of strange applicants. It is an old saying, and an accurate one, that it is necessary to live with any person to know him or her, and those who have, by experience of men, more than once discovered that the outward appearance is a misleading indication of the real man, have registered certain mental reservations when reading the seductive literature of "professors" of character analysis.

It is therefore refreshing to read the whole-hearted condemnation of the pretensions of those who undertake to judge character by outward signs, contained in a recent article in "The Scientific Monthly", by A. F. Payne of the University of Minnesota. Mr. Payne states that no cerebral location of traits of character is known to exist, and that there has never been any correspondence traced between the volume, shape or weight of the brain, which moreover does not necessarily conform to the outward shape of the skull. This sweeps away every pretension of the physiognomist and that pseudo-scientist, the phrenologist. On the basis of physical stigmata alone it is impossible to decide whether any individual is a desperate or degenerate criminal, a pervert, a mediocre person or a genius, an idiot, an imbecile, a madman or a fool, states Mr. Payne, and in this opinion he will probably have with him the average police officer.

In concluding, the article mentioned, states: "the claims of character analysis rest on assumptions entirely unwarranted by the facts. This being the case we can assume that its use in any situation of importance will be misleading and harmful."

In other words, a whole lot of buncombe has been foisted on a credulous public. The analysis of character which rests upon known facts regarding a man's personality and ability, recorded over the longest possible period, will probably continue to provide the basis for judging men's suitability for employment. Despite the text-books of the character analysts, the "boss" will probably know that if Bill Jones has a retreating chin he is no nincompoop, and that despite Jack Brown's eagle nose he is neither a financial genius nor a leader of men.

Mr. Taft says with regard to his fellow-citizens, that "the shallows murmur, but the deeps are dumb." Canadians have long realised what Mr. Taft so felicitously phrases, and that is why they are not perturbed by a number of absurd and obviously improper suggestions contained in United States newspapers. Mr. Wilson said his countrymen were a "mediatory" people, and Mr. Taft has classed certain unrepresentative sections of them as being obsessed by "other worldliness". There are just a few vociferous persons over the line, however, whose mediatory proclivities amount to meddling, and whose other-worldliness amounts to treason to the United States itself. This comparatively small group of persons has its counterpart in the British Empire, and in both instances these clamant minorities are a source of much embarrassment to the rest of their countrymen. As these international bores are incurable they must even be endured.

The Manitoba Bridge & Iron Company is suffering from a lack of orders, and has found it necessary to reduce its working force by 150 men.

The Argument of the Canadian Iron-Ore Producer for Government Assistance

A Memorandum presented to the Tariff Committee of the Cabinet by the Algoma Steel Corporation Limited.

Canada holds within her bosom what might be called without exaggeration, the key to the solution of her national economic problems. It remains but for her to unlock that bosom and, all these problems will have been solved; by doing so, Canada will place herself on a parity with her prosperous neighbor to the south, and whether industrial, agricultural, or generally speaking, economic, she will take her proper place in the industrial world.

That key consists in the millions of tons of undeveloped low-grade iron ore, known to exist, in various parts of the country; but which, perforce, lie dormant, because of the lack of a helping hand to private enterprise, eager to risk its all, in the working of these vast deposits of potential wealth. Canada, by placing a bounty on the operation of these deposits, will, transform them into vast stores of wealth and energy—energy, which will spread itself to all the confines of the country and will manifest itself in every field of national industrial activity, and redound to the personal advantage of every citizen.

At the present time, it is admitted by all, that iron and steel are the basic industries of Canada. The Canadian iron and steel industry depends, one might as well say almost wholly on ore imported from the United States and other countries. These importations naturally have helped to turn trade balances against us and trade balances are a matter which affect everyone in the country, whether he will it or not.

Canada has within her domain many deposits of low-grade iron ore, which, with a little treatment, would be of as high a quality for smelting and manufacturing purposes, as the best American ore. But, these processes of treatment are costly and it is not just that private enterprise, engaging upon the work of opening up this vast national storehouse, should be left to do the work unaided. Just as a bounty on the iron and steel industry stimulated these industries to the general advantage of Canadian manufacture, Canadian agriculture and Canadian people as a whole, and placed these on a solid foundation; so also, will the granting of a temporary bounty for a nominal period, say of fifteen years, give the great nation-building industries the wherewithal to forge ahead with the work, by calling upon the material lying at their very doors; raw material which, at present, is inaccessible to them on account of the difficulties met with in reaching it and putting it into a commercial condition for manufacture.

Such a bounty would have the almost immediate effect of developing ore properties in various parts of the country, from coast to coast. It would put Canada forthwith on her own feet as it were, and enable her to cope, single handed, with all her great national industrial problem, without being, at present, at the mercy of a friendly neighbor in the matter of getting her raw material.

In fact, when we look back upon the World War and realize what a great part Canada played therein, in the matter of supplying munitions as well as the sinews of war, we cannot be struck by how much Canada was dependent upon goodwill of a friendly neighbor, in playing this glorious part. Had it not been that the ore markets of the United States were open to the Canadian Steel industry, whither would Canada have looked for the supply of the raw material needed in its war industry notably the making of munitions? Thus, whether we look at the question from a view point, merely economic or from a view point of potential national emergency, the vast, unlimited stores of iron ore lying dormant beneath the surface of this magnificent country—all for the want of a helping hand to aid in their development—take on the aspect of a national tragedy. For Canada to-day is paying out hundreds of millions of dollars for United States products, which she has in abundant quantity, in her own back-yard. All she needs is the proper spirit to go and develop it. And this spirit can manifest itself in no better way than by granting a bounty on every ton of ore which private enterprise can develop.

Agricultural and forest products are prosperous, fisheries boom, manufacturing establishments grow, mines and minerals are gaining in value and importance. The one great question of national concern is the non-production of iron ore. The one solution for that great essential question, is a bounty, if Canada is to do her duty toward herself, toward her industries and toward her citizens.

Canadian iron ore is a matter of national concern. This outstanding and important fact is one which, at this stage of world-wide reconstruction and Canadian national development, deserves and requires the earnest consideration of Canadian statesman and brings up the following questions.

(1) What is the iron ore situation at the present time?
(2) What may be done to improve this situation?
(3) What results would follow?
(4) What objections are there to the remedy proposed?

If the facts hereafter adduced are substantially correct, and conclusions drawn are substantially sound, those in authority should, without delay, shape and put into effect a policy which will develop our iron ore deposits and permit Canada to take advantage of her great opportunity to save and serve herself, and to sell the world beneficiated iron-ore.

1.—What is the Situation at the Present Time?

Canada has not, at the present time, any known deposits of iron ore that are marketable in their natural state. The last known deposit (the Helen Mine) was exhausted in 1918.

Canada has vast deposits of low grade-iron ores (see Appendix 'A') which may be beneficiated; and those experimented upon have shown that a high grade beneficiated product, desirable for furnace use, can be produced.

Experimental work, developed and proven by private capital and enterprise, has demonstrated the feasibility of making a high-grade beneficiated iron ore product, very suitable for blast furnaces, but, without vast sums of private capital and temporary government assistance, not as a commercial success.

At present, practically 95 per cent of all ore smelted in Canadian blast furnaces, is imported from the United States and Newfoundland.

In addition to the raw ores imported into Canada, there is also an import of iron and steel products which, in 1918 amounted to over $186,000,000 and in 1919 $1[illegible]10, and which, for a period of several years, has exceeded an average of $125,000,000 per annum.

Payment by Canada for these ores and iron and steel products requires annually a tremendous amount of money, which, going out of Canada, helps to swell an adverse trade-balance, particularly with the United States.

Nearly all the low-grade iron-ore deposits require more or less costly treatment (beneficiation) before they can be mined and smelted at a profit. After long and costly experimentation, the technical problems of beneficiation have been solved. A large amount of money has been spent in this pioneer work, the possibilities have been absolutely demonstrated, and success on a commercial scale will result, if the operators are extended assistance in establishing the industry.

The known deposits of iron ore, susceptible of beneficiation, represent supplies for years to come, and only the fringe of Canada has been prospected. The potentialities of the unprospected territory are enormous.

The Algoma Steel Corporation Ltd. have experimented extensively with the siderite ores of Michipicotem. These ores, with an original iron content of 35 per cent and sulphur content of 1 per cent and higher, are roasted in rotary brick-lined kilns, raising the iron content to 50 per cent and reducing the sulphur content to 0.16 per cent. The cost of roasting, which is done with powdered coal, was in 1918 $1.85 per ton, and in 1919 jumped to $3.64 per ton, on account of high price of coal, one ton of raw ore making .7 ton of finished ore. That this beneficiated ore is a first class commercial ore is shown by the fact that the burden of the Algoma Steel Corporation's furnaces in 1915, under war pressure, was 95 per cent Canadian ores, one-half being Helen Mine hematite, the other half being beneficiated siderite. 80,000,000 tons of this siderite ore requiring beneficiation, has been proved up by this Company, and there are available several other large deposits, the tonnage of which has not yet been proven up by diamond drilling.

Mouse Mountain, Ltd., operate a group of magnetite properties at Sellwood, Ont. and have large reserves. They also have proven the feasibility of converting low-grade ores into a desirable commercial product.

Production of this beneficiated product must be carried on upon a large scale, to reduce costs, and vast sums of private capital are required for this purpose.

2.—What May Be Done to Improve the Situation?

Those interested in the production of Canadian iron ores are of the opinion that, if the Canadian Government would pay a bounty of $1.00 per long ton on the raw ore, for a period of fifteen years, it would enable such ores to be produced at a profit, and make them commercially saleable. They believe this to be sound and economic business, from the standpoint of the Canadian Government.

The Dominion Government is asked to grant a bounty for (15) years to promote iron-ore mining in Canada, and the bounty of $1.00 per long ton is suggested, payable monthly in the following manner.

1. When the ore is milled, treated or roasted, (as in the Moose Mountain process) or (Algoma Steel Corporation Ltd.) on the weights of the raw ore going into the milling, treating or roasting process; 2. When the raw ore is not milled, treated or roasted but is picked or assorted, then the $1.00 per ton would be payable on the [illegible] of the picked or sorted product going to the furnaces.

A bounty of $1.00 per ton applied as the case might be, as above set out, would have the effect of stimulating the production of iron ore in Canada; and those seeking such assistance by way of bounty show their good faith and are content that such bounty should be payable by the Government on the product of treatment.

It is pointed out that such bounty should not be restricted to Canadian ores consumed in Canadian blast-furnaces, but that it should be payable, as well, on any such product exported; because, to carry on this industry at a profit, production must be on a large scale and markets must be found wherever they exist; but the effect of such sale, for points outside of Canada would be to affect Canada's trade balance favorably and increase industrial activity in Canada.

It is to be noted that the foregoing plan of assistance to the iron ore industry of Canada proceeds upon the principal that private capital takes all the risk of success or failure, and first establishes the industry; and produces its product before it calls upon the Government for payment of the bounty.

The following definite statements summarize the reasons why this request should be granted:

1. Every dollar spent is paid to labor, there is no natural increase as on a farm and every dollar is kept in Canada and paid out to Canadian workmen.

2. An established iron and steel industry is a vital national necessity.

3. The rapid development of our natural resources is the only means of meeting the financial obligations created by the war, and of solving the problem of reconstruction.

4. Canada must face the task of making the nationalized railways pay. Mine products are the largest single source of railway traffic. In the United States the mining industry contributes between 55 per cent and 60 per cent of all freight moved. In Canada less than 40 per cent originates thus.

5. Iron ore mining produces a larger volume of freight traffic than any other branch of the mining industry.

6. Canada possesses abundant deposits or iron ore accessible by rail, but the known deposits are not high grade.

7. The total consumption of iron ore in Canada in the year 1918, was 2,242,337 tons, for 1919, 2,284,966 tons. The amount imported for 1918 was 2,154,592 tons for 1919, 2,174,166 tons. The Ontario blast furnaces, except for the small amount (96,745 tons in the year 1918 and 78,391 tons in 1919) of domestic ore used, depend entirely upon ore imported from the United States.

8. Present economic and social conditions make immediate action imperative.

9. The granting of a bounty would involve only a small annual outlay and would bring an overwhelmingly large return by the stimulation of industrial activity.

As the total output of iron ore from Canadian mines during the year 1918 was 206,820 tons, in 1919, 197,170 tons, and 127,826 tons in 1920, and so no large increase may be expected immediately, the amounts accruing to mine operators, during the first two years of payment, will scarcely total quarter of a million dollars. The amounts payable thereafter, depending as they do upon ore actually mined and beneficiated, simply will be a measure of the growth of the industry. The larger they are, the larger will be the benefit to the country generally.

As mentioned above, it has been demonstrated, on a commercial scale, after long and very costly experimentation, that low-grade Canadian ores can be converted into the highest grade of ore by various treatments, which may be referred to collectively as beneficiation.

The opportunity for building up a large domestic and export trade is evident. The need of increasing ore-production and enlarging smelting operations is more than evident. It is worth noting the beneficiation of low-grade iron ores, which is successfully carried on in Europe, is being introduced more and more widely in the United States, Cuba and Brazil.

The tonnage of Canadian iron ore, smelted in Canada annually has fallen from about 300,000 tons in the year 1915 to 149,000 tons in 1920. Both ore smelted in Canada and ore exported are, with the exception of very small tonnages from Quebec, Eastern Ontario and British Columbia, made up of the output of the two corporations mentioned. There is no reason, now that the processes of beneficiation have been commercially developed, why such establishments should not be duplicated in Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia.

It is apparent that the successful operation of iron mines means a great deal more than giving employment to so many miners. It implies a constant flow of freight traffic, in contrast to farming, which yields only intermittent freight.

The Dominion Government has been memorialized by a large number of Boards of Trade and other organizations praying for the granting of this bounty for a period of fifteen years. It may be noted that the $17,000,000 of bounty formerly granted during the period of 1896 to 1912 was wholly in the form of a bonus on the production of iron and steel. While, without it, Canada today would have very few blast furnaces, its incidence was not such as to stimulate the production of domestic iron ore. Nor was the practice of beneficiation sufficiently developed at that time.

The stress of the past six years has shown the need of any country to be self-contained. A domestic supply of iron ore would be a long step in this direction, as far as Canada is concerned. The former bounty on iron and steel largely led to the establishment of the furnaces and steel mills, which played so large a part in Canada's share in the production of munitions, during the war. The bounty now proposed will, help materially, to provide the ore needed for these furnaces and thus complete and increase the national equipment for the production of iron and steel.

3.—What Results Will Follow Bounty?

They would be:

1. The rapid development of our iron ore resources and further discoveries of mines by prospectors.

2. The creation of a larger volume of freight traffic than in any other branch of the mining industry, and in increase in receipts for the Canadian National Railways, along which lines lie tremendous deposits of iron ore.

3. The retention in Canada of large amounts of Canadian money now sent out of the country for the purchase of foreign iron-ore, and the receipt by Canada of a large amount of foreign money arising from the sale of Canadian ores.

4. The employment and investment of foreign capital in Canada.

5. The expansion of the iron and steel industry, around these will cluster by-product plants, alloy, furnaces, rail mills, slag-cement works and sources of other subsidiary plants, building up of communities, adding materially to the wealth and resources of the nation; expansion of agricultural industry on lands tributary to the mining and smelting centres; larger markets for the farming industry and increased consumption of manufactured products.

It is worthy of note that under the bounty formerly granted for stimulating the production of iron and steel, Canada has to-day blast furnaces and steel works of tremendous importance to the country.

6. For every ton of ore upon which Canada would be required under such a policy to pay a bounty of $1.00, there would be left in Canada in actual wages for production, a sum greater by three times the amount of such bounty.

7. Last, but not least, the production of Canadian iron-ore will complete the national equipment for the production of iron and steel, place Canada in a position of greater independence, and assure to the blast furnaces and steel works, a home product which, in any future time of national stress, will enable her to carry on within her own confines, the complete production of iron and steel, independent of the needs of a foreign, though friendly neighbor, and if they should put an embargo or export duty on high-grade iron ore, our Canadian steel plants would not be able to complete, and would have to close down, which would be a national disaster.

4.—What Objections are there to the Policy Outlined?

Free trade and low-tariff men will, on principle, object to the payment of a bounty. Considerable discussion has already taken place among members of the House of Commons on the proposal; many are favorably disposed; other are opposed. The principal opposition comes from the members of the Middle West; but upon acquaintance with the proposal and a frank discussion of the matter, many have conceded the merits of the request.

Some members from the West would appear to be personally favorable, but are impressed with the public sentiment of the West against such a proposal. Examination of this feeling, however, has shown that the basis of all the Western opposition to special concessions or assistance of tariff is because there is, in the back of their minds, the feeling that such a policy means increased cost to the consumer of the product. With the inherent opposition of the West to tariffs, 'Bounty' is put in the same class, and, therefore, is misunderstood.

The best answer those seeking the bounty can give to the objecters is to point out that the applicants for bounty do not seek any protective tariff, but are willing to invest their capital and develop the industry without a cent of tariff protection. In other words, the blast furnace man may still purchase in the cheapest market, whether it be in the United States, Newfoundland or any country, and the Canadian product mined under this proposed policy must compete and can be sold only where it is as good or better, and comparatively, as cheap as can be obtained elsewhere.

It is true that the bounty of $1.00 per ton must come from the exchequer of Canada; but that will be distributed per capita over the entire Dominion, and the net result to be decided is: Is it good business for Canada to pay $1.00 per ton bounty, after private capital has first expended in wages alone, three times that amount, in Canada, to earn such bounty?

Other and equally great results, such as increase of population, increase of tonnage for railways, subsidiary interests and industries, new capital, national iron independence, are thrown in for good measure.

When we consider the amount of money spent yearly upon agriculture by the Dominion to the end that the farmer may grow better and greater products; of the national investments in the railways, now clamoring for tonnage; contemplate the trade avenues now opening for Canadian development; when we gauge the tremendous part the iron and steel industry plays in the development of the country; and are convinced that, if Canada is to grow and take advantage of opportunity now, her needs for iron and steel will be enormous, all must realize that it is incumbent upon the nation to have some policy evolved to stimulate the production of iron ore.

With European competition weakened by the disastrous effects of war, what reason has Canada to believe her iron and steel products will not cost her more, and her development, to that extent, be retarded, if those countries, upon which we depend for our raw supplies and manufactured products, decide to advance the price, or to conserve their raw products?

Note.—The memorandum, as presented, was accompanied by diagrams and tabulations which are not reproduced here.

PROJECTED STEEL PLANT IN BRITISH COLUMBIA.

The second Annual Report of the Department of Industries in British Columbia contains a report from the Committee appointed to study the available markets for steel and steel products in the territory that could be served by a steel plant situated in British Columbia. The report is made by Messrs. Nichol Thompson and J. A. Mc. Vety, members of the Advisory Board and the Industrial Commissioner, Major Martyn. The report finds that there is a market on the Pacific Coast for two million tons annually of iron and steel, including tank, ship and boiler-plate, merchant bar, tool and mining steel, structural steel, shapes and angles, and light rails. Mr. Nichol Thompson, who has been interested in the sale of steel products for many years, says there is a market in the coast territory from British Columbia to Los Angeles for one thousand tons per day of foundry pig-iron alone, or 2,000 tons per day if such iron can be produced anywhere near the cost of steel-scrap—at the date of the Report—from $27 to $30 per ton.

With regard to the export market, it is stated that at present Canada exports little or nothing (this is only true of the Pacific Coast) while the United States exported through Pacific ports approximately $100,000,000 worth of iron and steel products yearly.

The reports states that a steel plant in British Columbia is a necessity, not only from the local viewpoint, but also in the opinion of many of the prominent steel men along the Pacific Coast of the United States.

It is stated that the British Columbia Government has entered into an agreement with the Coast Range Steel Company to pay a bounty not exceeding three dollars per long ton on pig iron manufactured from ore mined in the province. The agreement sets forth that British capitalists are prepared to invest the necessary capital, not exceeding ten million pounds, in the establishment of the industry if the engineers now engaged in examination of the question report in favor of such establishment.

It is to be hoped that those who are proposing the establishment of a steel plant in British Columbia, before committing themselves to such large expenditures are indicated by the mention of a sum "not exceeding ten million pounds," will review the history of the Canadian steel industry in the East, and seek to avoid some of the pitfalls that they may otherwise run into. For the usual type of blast-furnace plant, using coke, the first thing to be secured is a large supply of coal that will make good metallurgical coke, as free as possible from sulphur and excess ash. The second requirement is a site as close to the pitmouth as possible, and with a tidewater location suited to assemblage of ore and fluxes by modern freighters with discharging appliances of up-to-date design. It is essential that the operations of the coal mines, the manufacture of coke, and the heat-using metallurgical processes shall be concentrated where every possible heat unit can be extracted and used on the spot, and that the electrical power generated shall be available for colliery, steel-plant and loading and discharging operations in common. There is only one part of British Columbia where this combination of conditions is to be found, namely on Vancouver Island, and it will, in our opinion, be a great initial error if any point on the British Columbia coast is selected.

A local steel industry, using electrical power, or powdered coal, for the making of steel and iron from scrap, such as is being very successfully operated at Selkirk, near Winnipeg, is of course a different proposition; and, for such an industry, nearness to a large centre of population, availability of developed hydro-electric power, and distributing considerations present another, and quite different problem from that of the ordinary blast-furnace, coke-oven, rolling-mills type of steel plant that is usually associated with, and grows out of a coal-mining industry.

The Dominion Iron & Steel Company had an original capitalization of $25,000,000, and that of the Steel Company of Canada is $11,500,000, and both these companies have establishments far larger than is indicated as being desirable in British Columbia either by reason of the known deposits of coal and iron in that province, or the estimated market.

The first necessity for a large-scale steel plant in British Columbia would be the acquirement of large tracts of coal-bearing lands with a content of cheaply-mined coal of metallurgical quality suited to the making of good coke. We incline to the opinion that such a property would be difficult to obtain, and there would be far more hope of permanence to a steel industry in British Columbia that would grow out of an existing coal-mining corporation, or by expansion of foundry enterprises already in existence, than from the advent of a large company that will have all its problems to work out and will buy its experience very dearly.

POSITION DESIRED.

The 23rd Annual General Meeting of the Canadian Institute of Mining and Metallurgy

Montreal, March 2nd to 4th, 1921

The 23rd Annual General Meeting of the Canadian Institute of Mining and Metallurgy was held in Montreal from March 2nd to 4th. The proceedings during the first two days were devoted to business matters and to the reading of papers dealing with general mining in Canada. Particular attention was paid to petroleum occurrences and to the fuel problem, and on the concluding day the sessions were arranged to deal more particularly with iron ores and ferrous metallurgy.

The first paper read on the morning of the 4th March was prepared by Mr. Angus W. MacDonald, the Superintendent of Industrial Relations of the Dominion Steel Corporation. This paper described the manner in which the related activities of the Dominion Steel Corporation's scattered collieries, iron-works, and ore and limestone mines, in so far as concerns all questions of employment, workmen's housing, and what is known as welfare work, had been placed under the general direction of a department of industrial relations.

Recreational facilities, employees' benefit societies, hospitals, children's playgrounds, sanitation, fire-prevention, first-aid work, housing, etc., were discussed in this paper. The object of the department is to reduce labour "turnover" to a minimum, to keep employees, once they are obtained, and to put them at the work they are most adapted for.

Mr. DeBlois of the Nichols Chemical Company emphasised the necessity to put a considerable portion of the responsibility for direction of such activities on the employees themselves, even to the extent of partial financial support, and the avoidance of any suspicion of paternalism.

Discussion on Increased Use of Canadian Iron Ores.

Mr. Cowie, of the Algoma Steel Corporation, opened the discussion by reading the brief presented by the Algoma Steel Corporation to the Tariff Committee of the Cabinet.

Since this statement has been presented, the Moose Mountain Iron Mine has closed down, and the Algoma Company would in all probability be compelled to close its ore mine. The situation was a most serious one. If we had in Canada, said Mr. Cowie, only one gold mine, one silver mine, one copper or one nickel mine producing, would we not all get together and try to keep them producing?

Mr. T. B. Caldwell — who received hearty applause upon rising — detailed his personal experience in the iron-ore mining industry in Canada. He had opened an iron mine at Wilbur, on the Kingston and Pembroke Ry. in 1880, and later had opened an iron deposit at Calabogie. Realizing that with the development of the great iron deposits of the Western States the Ontario deposits had become relatively small he had eventually become interested in the Temogami deposit, of the great value of which he was still convinced. He related the favorable opinion passed upon this deposit by the late Dr. Barlow and by Dr. Van Hise, the late O. LeRoy, and others.

There had been many discussions on bounties, but with such little result that he wished to suggest some other plan to interest the government. He suggested the Dominion Government should set aside a sum of money for the intensive testing and drilling of some promising iron-ore area. This he urged because he believed our iron-ore resources were imperfectly known. Mr. Caldwell read a letter he proposed to address to the Government seeking an appropriation of $300,000 for studying the iron-ore problem in Canada, and for drilling properties. He suggested that cost of drilling could be recouped from royalties imposed on iron-ore shipped from the properties proved.

The Secretary said that for a long time he had earned his living by trying to make pig-iron from Ontario iron-ores, using magnetites from Calabogie and Central Ontario. Later on, in Nova Scotia, had used the local brown ore, and had attempted to use a highly siliceous magnetite of desperately poor quality in that Province.

As to bounties, he was absolutely sure the country would never have been in a position to supply the iron and steel required for war purposes if it had not been for the initial assistance of the bounties. The system of bounties did most materially and efficaciously help our iron and steel industry. The matter had of course to be viewed from the national standpoint, but nevertheless he did not believe that at this time a request for a bounty would be favorably received. A deputation from British Columbia had visited the Government some years ago, but upon examination their representations were not found to be well founded, and it was no use making any proposition to the Government unless it was economically sound.

Most of our domestic ore supply is low-grade magnetite, high in sulphur, high in silica and sometimes high in phosphorous. It is not material favorably regarded by smeltermen. Beneficiation is therefore necessary. This means much planning and investigation, and much capital, and there must be a large tonnage of suitable ore in sight to justify this. Iron-ore deposits cannot be gauged as to quantity as one would gauge a silver or a gold occurrence. Beneficiated iron-ore provides a uniform and desirable product, but it is difficult to mix with other ores. Mixing is not attempted in the United States. An assured supply, sufficient to keep one or more furnaces working on beneficiated ore is necessary. The mistakes of the past should not be forgotten. An attempt has been made to beneficiate the Moose Mountain ore, but it had been an attempt to develop special machinery rather than a process. Other mines are closed down at present, including nickel and silver mines. The Government must be persuaded that the beneficiated ores would be used in Canada. They will not be interested in the export of beneficiated ores.

Mr. Caldwell's suggestion as to an appropriation is good.

Mr. B. Neilly said that the soundest opinion was that the iron and steel industry and national progress were directly related. There are Canadian ores that can be beneficiated, but not to meet American competition. How is the spread to be taken up? The discussion as to whether a bounty should be paid or

whether an appropriation should be made he thought was immaterial as it was the same thing. He mentioned that in the early history of the United States and of Britain also the importation of iron and steel goods had been prohibited in the interests of the home industry. He moved a resolution that

> "Whereas the importance of the iron and steel industry is apparent, and only five percent of requirements is supplied from domestic iron ores, that this meeting go on record as advocating in principle the payment of a bounty on beneficiated iron-ores."

Mr. Goodwin said that so far we had attempted in Canada to smelt iron ores in furnaces of United States design, using United States practice, but our ores are dissimilar to those of the United States. Blast-furnace practice had been devised to suit local conditions in other countries. British furnaces are distinctive, and most radical departures from accepted practice have been carried out in Norway and Sweden. We should not assume that beneficiation is always necessary, but should suit our methods to our ores.

Electrical Smelting Progress.

Dr. Stansfield referred to his experiments in electrical smelting. There were two main difficulties in Canada, first, the supply of iron ore and secondly the supply of fuel. We had in Canada a considerable supply of electric power, and he had been experimenting for some years to devise a process to suit local conditions. It seemed now somewhat probable that the improvements which have been made in the reduction of iron-ore at temperatures lower than their melting point will bring the possibility of electric smelting into the region of practical operation. The process in general is to crush the ore, heating it, or mixing it with some form of carbon at temperatures about 800 degrees for hematite, or 900 degrees for magnetite, and making an iron sponge, which is the starting point for subsequent electrical furnace treatment. Dr. Stansfield said it seemed to him quite probable that before long we should be able to reduce hematite ores so reasonably that their commercial utilisation will be possible. This would alter the complexion of the iron-ore situation in Canada, and the process might permit the utilization of low-grade fuels such as peat and wood.

Mr. Cowie said the increase in pig-iron production was a result of the bounties, and pointed out that the bounties paid by the Government during the bounty period was proved to have been returned by the increase in customs duties at the ports of Sydney, Sault Ste. Marie and Hamilton. Similar results might be expected to follow a bounty now.

Mr. Edwin Ludlow referred to a satisfactory grade of metallurgical coke which had been obtained from a mixture of the low-volatile coals from Jasper Park with the higher-volatile coal of Vancouver Island, at his suggestion. He mentioned that when looking over Vancouver he had noticed steel-ships building and was told the iron for their fabrication came all the way from Pittsburgh, which he hardly considered good business.

Colonel Dwight—whose connection with the Dwight-Lloyd process used at Babbit gave especial interest to his remarks—said that the problems confronting Canada in developing her natural resources were ones that appealed very strongly to confreres in the United States, as they were beginning to be troubled with similar problems.

Possibly all present were not aware that right alongside the development of iron ores in the Mesabi Range there had grown up a new enterprise for the beneficiation of taconite ores, which form an important part of the ore deposits of the Lake Region, and a problem that is now being attacked in a very serious way. Profiting by the experience in the low-grade porphry copper-ores, the Mesabi Company, financed by the well-known house of Hayden Stone & Co., who have had much experience and success, headed by Mr. Jackling, have undertaken to beneficiate these taconite deposits. They have gone at it intensively, have studied the problem for several years and have tried many thousands of tests. After passing through all the different stages found to be necessary they are now proceeding with the construction of their first unit which will demonstrate on a fully-working scale the practical success of the enterprise.

Col. Dwight gave a brief description of the process of beneficiation. Commencing with a crude agate-ore containing 30 to 35 percent of iron, this is blasted out and gathered by steam shovels, crushed to a fine powder, concentrated in log-washers — modified by some electrical device that has been worked out, — de-watered, and passed over Oliver filters, after going through a Dorr classifier; is then mixed with the necessary amount of carbon and passed along to the sintering furnaces. The reaction was interestingly described by Colonel Dwight, who likened the process of the sintering to the burning of a cigar, the combustion proceeding from the top downwards and developing a temperature of from 1,000 to 1,200 degrees C., inducing a condition of semi-fluid mobility. The resulting sinter is not unlike coke, and in the case of magnetite is a material that responds very readily to the reducing action of the blast furnace.

In concluding, Colonel Dwight said that the application of this Mesabi development to Canad was *that if the other economic problems connected with the similar ores in Canada could be worked out, the beneficiation problem had already been solved.* He wished the Institute and the industry in Canada success in its endeavours.

Friday Afternoon.

In the concluding afternoon of the meeting, papers were read by R. L. Lindstrom on "Steel Castings for Mining Purposes" illustrated by lantern slides showing microphotographs bearing on the methods used to ensure sound castings for mining purposes and on annealing and heat-treating. Messrs. W. S. McKee and J. H. Blake presented a paper on "Manganese Steel Castings in the Mining Industry".

Excursions were made to the Davidson Steel Foundries at Turcot and to the works of the Dominion Engineering Works at Lachine. About 35 members accompanied these excursions.

At the Davidson works, the party was shown round by Mr. T. R. Davidson, General Manager, seeing the Snyder electric furnaces, the transformer-room, and the casting processes.

At Rockville, the newly equipped works of the Dominion engineering Works were seen, the party being shown through by the President, Mr. G. H. Duggan and his assistants. The Foundry and the Main Shop are not excelled in Canada. Castings of unusual size and fineness can be made, and the machine tools are of the largest dimensions. The manufacture of paper-making machinery, and water-wheels, are this Com-

pany's especial work. Two water wheel units, which were seen under construction in the shop, for the Cedar Rapids and Shawinigan Companies, are the largest of their kind yet constructed.

The large size of the castings requiring to be machined is indicated by the purchase of a 35 ft. mill —the foundations of which were seen under construction by the party — shortly to be installed. It is understood this mill is only equalled in size by one installed at the Brooklyn Navy Yard, and that it is only approached in Canada by a 32 ft. mill at the Peterboro Works of the Canadian General Electric Company.

SALE OPTION GIVEN FOR ATIKOKAN IRON MINE.

J. J. O'Connor, Port Arthur.

That the iron ore resources of Northern Ontario are about to receive the active attention of experienced iron-ore operators, was announced at the meeting of the Port Arthur City Council on the 1st instant.

Mr. J. Dix Fraser, representing the National Trust Company of Toronto, appeared before the City Council of Port Arthur, and asked for the ratification of an agreement, made by the National Trust Company, with Clement K. Quinn, of Duluth, Minn. at a meeting of the Council on the 1st inst.

Mr. Fraser asked for the ratification of an agreement made between the National Trust Company, and Mr. Clement K. Quinn, for the sale to the latter, of the properties of the Atikokan Iron Mine, situated on the Atikokan River, 127 miles west of Port Arthur, on the Canadian National Railway.

The City of Port Arthur has a one tenth interest in the mine and blast-furnace of the Atikokan Iron Company, the last-named being located at Port Arthur.

Mr. Fraser stated to the City Council that the National Trust Company had granted to Mr. Quinn a ninety-day option to purchase the Atikokan Iron Mine, in order that he may make searches of title, and carry out preliminary work necessitated by the transaction. The agreement made between the National Trust Company and Mr. Quinn, was, necessarily made subject to ratification by the City of Port Arthur. The agreement was practically made complete, when the Council, by resolution, authorized the Mayor and City Clerk to "execute the request of the National Trust Company for the sale of the Atikokan Iron Mine."

Mr. Fraser stated to the City Council that the consideration was $1,500,000, payable $50,000 within one year and three months from the date of commencement of operations, and the balance of $1,450,000 in yearly payments of $100,000, the balance due bearing 6 per cent interest.

No intimation was given as to the probable date of commencement of active operations at the mine, as Mr. Fraser stated he was not in possession of Mr. Quinn's proposed program, but, as Mr. Quinn has been given the right to carry on extensive operations at once, it is presumed that active mining will begin on the conclusion of the transaction, and that the Atikokan will enter the shipping class during the current year.

During the currency of the payments mining is to be carried on subject to the approval of the National Trust Company's representative, Mr. J. Dix Fraser, who will act as an inspector. This is for the purpose of guarding against the possibility of taking out only the high-grade ore, and abandoning the property at a later stage.

Mr. Fraser also made the statement, that, while the furnace had been separated from the mine property, he had every prospect of a sale of that too, within a comparatively short time. He intimated that negotiations were well under way to that end, and would likely be successfully concluded.

Mr. Quinn is one of the most enterprising and successful iron-ore operators on the Minnesota ranges, with offices at Duluth, Cleveland, and on the various iron ranges of Lake Superior. His advent upon the mining activities on the iron-ore ranges of Northern Ontario is hailed with the greatest satisfaction. It is felt that his standing in the iron-ore world is a sufficient guarantee that mining and shipping of iron ore from Ontario ranges will soon be an actuality, and will lead to further, and more extensive operations on many of the iron ranges on the Canadian side of Lake Superior.

DR. ALFRED STANFIELD AWARDED PLUMMER MEDAL.

Dr. Stansfield who has been awarded the Plummer Medal for 1919 for his paper on "Electric Furnaces", was born at Bradford, England on March 18th, 1871, and was educated at London University, from which he later obtained the degree of D.Sc. For eight years following 1890 Dr. Stansfield was assistant to Sir Wm. Roberts-Austen at the Royal Mint, London, he was then appointed to take charge of the metallurgical and assaying laboratories of the Royal College of Science, London, which post he held until being appointed Professor of Metallurgy at McGill University in 1901. For almost twenty years Dr. Stansfield has been connected with the staff of McGill University, and is now Birks Professor of Metallurgy and head of the Metallurgical Department.

Dr. Stansfield is well known for his able research work, for the Dominion Government he made an exhaustive study of electric smelting of iron Sweden, he has also made extensive experiments in electric smelting of zinc and the production of zinc oxide paints at Shawinigan Falls. As a member of the Government Commission appointed in 1915 by the Minister of Militia and Defence Dr. Stansfield reported on the copper and zinc possibilities in connection with shell production. In addition to his University and consulting work Dr. Stansfield has taken his share in the development of the Canadian technical press, being editor for the first two years, (1918-1919) of "Iron and Steel".—From Journal "Engineering Institute of Canada."

DWIGHT P. ROBINSON & CO., OPEN MONTREAL OFFICE.

Dwight P. Robinson & Company, Incorporated, a large firm of engineers and constructors of New York, has recently opened branch offices in Montreal in the Dominion Express Building. Alexander C. Barker, Vice-President, is in charge of the office. The company is a consolidation of Westinghouse, Church, Kerr & Co., Inc., and Dwight P. Robinson & Co., Inc., and has done extensive construction and engineering work in Canada for the Canadian Pacific Railway, Canadian Salt Company, Canadian Crocker-Wheeler Co., Dominion Government, Aetna Explosives Co., Grand Trunk Railway and others.

PRODUCTION OF THE DOMINION STEEL CORPORATION DURING THE CALENDAR YEAR. 1920. (Est.)

The approximate figures of steel plant production, and of the ore and limestone mines, of the Dominion Steel Corporation, are furnished us, by courtesy of the Corporation, as under:

Marble Mountain—Limestone, net tons	208,802
Port au Port—Limestone, net tons	128,895
Wabana Ore Mined, net tons	654,010
Coke, net tons	338,149
Pig Iron, Gross tons	230,974
Ingots, gross tons	266,463
Rails (Standard), gross tons	15,425
Blooms, gross tons	192,030
Billets, gross tons	149,352
Rods, gross tons	92,296
Wire, net tons	24,157
Nails, net tons	16,978
Bars (rods & Bars), gross tons	1,857
Bars (Merchant), gross tons	608
Lt. Rails, gross tons	5,728
Sulphate of Ammonia, pounds	14,777,280
Tar, gallons (Imperial)	5,168,241
Benzol, gallons (Imperial)	291,102
Toluol, gallons (Imperial)	137,342
Naph. Solv., gallons (Imperial)	50,174
Sul. Acid, net tons	10,536

DOMINION ENGINEERING WORKS FIRST ANNUAL REPORT.

The First Annual Report of the Dominion Engineering Works, Limited, gives a balance sheet, but no profit and loss statement, the last-named calculation not being one considered advisable to attempt because of the initial nature of the enterprise, and the large number of suspense items arising from uncompleted contracts. Expenditures on contracts taken up to 31st December, totalling purchase prices of $3,400,000, have been made of $1,845,853, but it would only be possible to credit fully completed contracts to the extent of $200,000, the Board considered it undesirable to publish a profit and loss statement containing entries of so small a proportion of the expenditure on manufacture.

In regard to the progress of the equipment of the plant and the work on current contracts, the Report of the Board states, in part:

During the year there has been installed a large proportion of the additional plant required for the manufacture of water turbines of all capacities, including the largest possible to transport.

Work on some of these turbines is now in process, contracts having been entered into for:

2 Turbines for Laurentide Power Co., 20,000 h.p. each.

2 Turbines for Montreal Light & Power Consolidated (Cedars), 13,000 h.p. each.

1 Turbine for Montreal Light, Heat & Power Consolidated (Cedars), 1,500 h.p.

1 Turbine for Shawinigan Water & Power Co., 41,000 h.p.

4 Turbines for Spruce Falls Company, 2,900 h.p. each.

The Cedars Rapids wheels are duplicates of those already installed, and were until last year the largest wheels that had been built. The Shawinigan wheel will be the largest wheel of this type in existence.

The business entered up to the 31st December, including that taken over from the Dominion Engineering & Machinery Company amounted to $3,400,000, approximately distributed:

Paper-making machinery	$1,700,000
Hydraulic machinery	1,650,000
Foundry sales	56,000

1920 REPORT OF THE NOVA SCOTIA STEEL & COAL CO.

The report of operations and financial statement of the Nova Scotia Steel & Coal Company for 1920, in view of the transitory conditions of that year, should be regarded as very satisfactory. The volume of business was almost three times greater than in 1919, amounting to $19,558,479 compared with $6,889,941 in 1919, although the profits, reflecting a smaller margin of profit, were $2,376,085, or $182,780 in excess of those of 1919.

The common stock dividend was well earned, the amount available for common stockholders showing a ratio of 6.9 per cent, comparing with 5.73 per cent in 1919, reckoned on the capitalization. The rate of dividend maintained for some years has been 5 per cent annually. The disbursements of 1920 include two years dedeferred dividends on the preferred stock of the Eastern Car Co. The earnings did not fulfill the earlier promise of the year, and reflect the falling off in steel demand, which, the report of the President states, ceased almost entirely at Midsummer. Under these conditions, the important part played in stabilization of earnings by the combination of coal properties that is such a real asset of both the large Cape Breton steel companies, is made evident, although, as further stated in the President's remarks, the imposition of an export embargo by the Government in the Summer entailed a serious loss of profits to the Company.

A condensed statement of the Profit & Loss account for the past three years is as follows:

	1920	1919	1918
	$	$	$
Profits	2,376,085	2,193,305	3,535,525
Less Depreciation	561,582	554,593	206,968
Less Bond interest & Preferred Dividends	775,096	778,835	692,064
Less Common Dividends	750,000	750,000	750,000
Total Deductions	2,086,678	2,083,428	2,649,032
Surplus	289,407	109,875	868,492
Previous Balance	2,726,461	2,616,585	1,730,093
Balance to P. & L.	3,015,868	2,726,161	2,615,585

The position of the Company with regard to working capital is not so liquid as it was during the two previous years, and the balance sheet contains an item of $2,162,755 for bank loans which is new since 1919, and represents money tied up in storing coal and in stocks of steel products and money owing, which includes $952,452 due from the Government and other railways for cars delivered but unpaid for at the year end.

Excess of current assets over current liabilities compare as follows:

	1920	1919	1918
	$	$	$
Current assets	10,913,218	9,063,082	11,468,829
Current liabilities	4,445,856	1,319,524	1,403,750
Working capital	6,445,856	7,671,558	10,065,079

The Balance Sheet shows no very notable changes except in the matter of working capital. Property ac-

count, after a generous depreciation, shows an increase of \$570,000, and quick assets represented by war loans and cash total \$2,493,825, comparing with \$4,132,542 at the end of 1919.

It is understood the Company now controls the Acadia Coal Company's properties practically to the point of ownership, and its position is thereby much strengthened, as the Acadia Coal holdings constitute a most valuable reserve of coal of larger extent than was formerly supposed.

In reviewing the operations of the Company, the President, Mr. D. H. McDougall, says in part:

Coal Operations.

"The improved demand for coal which commenced in the autumn of 1919 continued during the greater part of the year, but perceptible slackening was noticeable in the early part of November and since that time it has decreased rapidly.

"The general shortage of coal in Europe and the threatened strike of coal miners in Great Britain increased the foreign demand very materially, and the company was able to secure in the early part of the year some very attractive contracts for coal for export. Only a part of the deliveries under these contracts was overtaken when an embargo placed on the export of coal by the Federal Government resulted in their cancellation and made it necessary to secure other employment for the steamers engaged for this business, the result of which entailed a serious loss to the company.

"It is regrettable that this overseas outlet for coal which was only secured after a great deal of effort on the part of the company was thus interfered with and we fear lost permanently.

"While for the moment, owing to the closing down of the blast-furnace and steel plant, the amount of coal being banked is larger than usual, your directors hope that as soon as navigation opens the demand for coal will enable the company to dispose of a reasonable amount of banked coal as well as the full output of its various collieries. The output for the year was 633,845 tons as compared with 550,965 tons in 1919."

Steel Operations.

"The operations at Wabana were restricted almost entirely to development work and consequently the output of ore was but slightly larger than last year, amounting to 265,755 tons, as against 213,410 tons in 1919. Of the ore mined 124,014 tons were shipped to North Sydney. There was also shipped to Europe 12,375 tons, of which 6,752 tons were shipped on a prewar contract and the balance sold f.o.b. Wabana. While ocean freight rates have fallen very materially, the depression in the iron and steel trade in both Europe and the United States has up to the present militated seriously against any considerable business in the export of iron ore.

"The demand for iron and steel products which was satisfactory at the time of the last annual report continued until midsummer, when orders ceased almost entirely. The company had accumulated a sufficient tonnage of unfilled orders to keep the rolling mills in operation until the end of the year. It was, however, considered advisable to shut down the steel plant at Sydney Mines about the middle of November, and, up to date, conditions have not warranted restarting this plant.

"The railways of Canada are still in need of rolling stock and track material, and it is anticipated that, in in the near future, substantial orders will be given out, of which, doubtless, this company will secure a reasonable proportion."

Coal and Steel Outputs.

	1920. Tons.	1919. Tons.
Coal..	633,845	552,044
Pig Iron made	73,829	35,676
Steel Ingots Made	114,869	58,238
Steel Ingots Cogged	117,958	54,645
Steel Billets Re-rolled	67,906	44,468
Total Shipments of finished steel, forgings, etc...	95,087	44,051

Two steamers were completed for the order of the Canadian Government, the "Canadian Miner" and the "Canadian Sapper" both of 2,800 tons, and a third vessels, the "Volunda" was built for the Company's own use, of similar tonnage.

The Eastern Car Co. constructed and delivered 1,462 standard-gauge freight cars, 10 standard-gauge snow-plows, and 157 narrow gauge mine cars. At the end of the year there was on order 200 forty-ton standard box-cars, and 500 fifty-ton box-cars, designed to carry grain.

STANDARD REQUIREMENTS OF SINGLE-PHASE DISTRIBUTION TRANSFORMERS.

Publication No. 2 of the Canadian Engineering Standards Association deals with standard requirements of single-phase distribution transformers, and in the preface is stated to have been drawn up primarily for the use of manufacturers and purchasers to express the recognised Canadian practice as to the standard sizes and construction of single-phase, oil-insulated distribution transformers. This question was originally taken up at the request of the Hydro-Electric Power Commission of Ontario, difficulty having been experienced owing to the lack of uniformity in Canadian practice regarding standard sizes, polarity, number and percentage of taps, and other important points. The Report, which is the work of the Sub-Committee on Transformers is not intended to include such portions of a transformer specification as are already sufficiently provided for in Canada by the very general adherence to such standardization rules as those of the A. I. of Electrical Engineers, nor does it cover certain points in regard to which general agreement does not at present seem possible. The Chairman of the Sub-Committee on Transformers is Mr. A. A. Dion, Ottawa Electric Company.

Copies of the specification can be obtained from the Secretary, Mr. P. J. Durley, at Ottawa, price 25 cents.

THE INCHCAPE BELL.

Lord Inchcape, the well-known English banker, has some things to say about trade conditions in Britain that have an application not confined to the British Isles. Some of his statements are quoted:

"What killed the boom a year ago was that nobody, whether he was a manufacturer, or a customer, a Government, a private employer or a working man, seemed to bother about costs".

"Excessive profits snatched during a boom have always to be paid for later on. Excessive wages bring the penalty of unemployment".

"A maximum wage is never too much for a maximum output. But a maximum wage for a minimum output is fatal not only to the individual but to success as a nation".

"As a nation we have nothing to fear, industrially or politically, from any foreign rival. Our real dangers are internal."

STEEL FISHING VESSELS.

Nova Scotia Fishermen Considering their Substitution for Wooden Vessels.

Consideration is at present being given in Lunenburg and other fishing ports of Nova Scotia to the possible advantages of substituting steel fishing-schooners for the traditional wooden-built type for deep-sea fishing.

The advantages of steel-built vessels compared with wooden vessels include a lower rate of insurance so long as the steel vessel retains her class, which should be from 25 to 30 years at least. It is next to impossible to insure wooden vessels at any reasonable premium after they are five years old. Owing to their large sail area, and the fisherman's habit of carrying as much sail as possible, wooden vessels get strained and have to be docked frequently for caulking. This cause of expense would be eliminated in a steel-built hull. The question of ballast is a serious one in the case of wooden vessels. It costs from two to three hundred dollars to ballast wooden vessels for a fishing trip. The rock has to be carted at considerable expense to the vessel, and then has to be thrown overboard as the fish are taken on at the Banks, a very unpleasant form of labour. A steel-built vessel could be constructed with water-ballast tanks amidships which would also provide the motive power for operation of the anchor windlass, and for hoisting sail and discharging cargo.

Opinions from prominent men in the local fishing industry are that there is a real need for a type of steel-built, two-masted schooner, fitted for deep-sea fishing, and it is understood the Nova Scotia Steel & Coal Company is contemplating the construction of a vessel of this type.

If such a type proved successful, it would lead to the building of larger sailing-vessels of steel, and there is much room for expansion in connection with cargo-carrying schooners for coastwise traffic in the Maritime Provinces. The number of wooden vessels abandoned at sea in sinking condition off Newfoundland and the Maritime Provinces would make a melancholy and significant list in recent years.

An example of a successful home-built cargo-carrying schooner, is the "James Williams" built at New Glasgow seventeen years ago. This vessel is still operating profitably in good condition with no higher insurance premium than when built. Also, for cargoes such as coal, the wider hatches of steel-built hull, and the greater cargo-space when compared with more bulky wooden construction, is a decided advantage.

The Nova Scotia Steel Company is aleo investigating the possibility of constructing small steel hulls, such as mentioned, by the use of electric welding, which it is expected will not only cut the costs of construction, but give greater rigidity to the hull.

The Trenton yard of the Nova Scotia Steel Company has completed its building programme with the delivery of the "Canadian Sapper" in December, and there is now under construction only a steel yacht, 137 feet long, 28 ft. 6 ins. beam, building for Baron Bliss, of Nassau, Bahamas which should be delivered toward the end of May.

At one time, as is fairly generally known, Nova Scotia was famous for its wooden ships and there seems no good reason why, by a process of logical evolution, this centre of the iron and steel industry in the East should not develop a specialized type of steel-built vessel, suited to local conditions, and made from local materials. No place in Canada could do it so well, or better provide the man-power required. One feature of steel-built ships, that is by no means negligible in these days, is that the superior deckhand accomodation usual in vessels of this type, and the greater use of mechanical devices to save manual labor under arduous conditions, attracts a better class of sailor than the "windjammer" tradition calls for. Also the addition of auxiliary engines and such modern necessities as electric-light installations are coming into vogue.

OBITUARY.

Charles E. Duncan, General Superintendent, Algoma Steel Company.

Mr. Charles E. Duncan, general superintendent of the Algoma Steel Corporation, Sault Ste. Marie, died at the General Hospital on February 26th, following an operation for appendicitis. His death, while not entirely unexpected, came as a shock to the wide circle of personal and business friends who held him in the highest esteem. His illness dated from the 19th.

Mr. Duncan was forty-eight years of age. He was an American citizen, born in Chattanooga, Tennessee, but he lived in Johnstown, Pa., most of his life, where he began to make steel as soon as he was old enough to work. He started on the Homstead Works of the Carnegie Steel Corporation, following in the same business as his father and working in every department of the steel and iron business, until he rose to be recognized as one of the best steel men in the country. At one time in his career, he was assistant general superintendent of the Bethlehem Steel Corporation, where he was personally highly regarded by Mr. Charles Schwab, the president of the company. Mr. Duncan knew the practical side of the steel making business as few men do. He commenced his work with the Algoma Steel Corporation of Sault Ste. Marie in 1909 and was general superintendent here until 1915, when he went to the Donner Steel Company of Buffalo, N.Y., and thence to the Pacific Coast Steel Company of San Francisco, where he was in the service of the United States government, which had taken over the plant. In April of 1920, when the late David Kyle died and Mr. J. D. Jones, who at the time was general superintendent, was made general manager, Mr. Duncan was recalled, and was engaged as general superintendent up to the time of his death.

The wide circle of friends who keenly regret Mr. Duncan's loss, regarded him as a man of unusual capabilities. He was broad visioned and possessed an almost uncanny knowledge of steel. He was a man who could mix on intimate terms with both the most prominent executives in the business and the ordinary workers in the mill.

He was a well proportioned man, physically and mentally, and regarded with respect by every one who made his acquaintance. The officials of the Algoma Steel Corporation, especially, regret his decease, as he was an invaluable member of the executive staff.

He is survived by his wife, a son, Ellis of Johnstown, Pa., his mother, two sisters and a brother, the four latter, also of Johnstown. His father, J. M Duncan, predeceased him by only three weeks.

The Utilization of Lean Iron Ores

An Account of the Progress towards Utilization of Lean Magnetites of the Eastern Mesaba Range by Grinding, Magnetic Concentration and Sintering. "A Wonderfully Big Undertaking."

By A. J. HAIN, in "Iron Trade Review."

Progress at Babbit, Minn., where the magnificent mining enterprise of the East Mesabi is underway, points to the conclusion that eventually there will be established on this site the largest mill in the world for the treatment of lean ores—a plant costing approximately $60,000,000 with a capacity for handling 100,000 tons of material a day, and producing between 30,000 and 40,000 tons of iron ore concentrates.

Such are the plans in prospect, and the East Mesabi Iron Co., has gone ahead with plans to the extent of providing for the expenditure of $4,000,000; all this leading up to and providing for the construction of the first unit, from which as a separate entity it does not expect to derive any profit. Profit must come through production on a much greater scale than is possible with one unit; the whole enterprise as it has developed, therefore, is but a step toward much greater effort, or failure.

In preliminary experimental work during the past five years $780,000 was expended to demonstrate the practicability of grinding the rock of the East Mesabi into a fine powder, separating out the iron oxide by electrical means and fusing this into a "clinker" for easy shipment and handling at the furnace. The first unit of the plant which is now being constructed at Babbitt will cost approximately $3,000,000, including the necessary trackage and appurtenances. This unit is being built as part of a general plan calling for 22 units, all of the same general dimensions and capacity. It will have a capacity of 2,000 to 3,000 tons a day.

It is expected that the unit will be in operation by the fall of 1921 and that 50,000 to 75,000 tons of concentrates will be shipped by the end of the year. The engineers in charge of the work consider that the project has passed the experimental stage so far as it relates to the character of the material to be handled and the process for handling it. Obviously new circumstances, problems and combinations will arise, and it is those which make up the uncertainties of the enterprise now being tried out at Babbitt, although the circumstances are foreseen and charted with precise, mathematical accuracy. As a mining executive, who has studied the details of the plan for several years, stated to the writer: "It is a wonderfully big undertaking."

The town of Mesaba marks the dividing line between the rich hematite ore bodies of the western end of the range and the magnetite formation of the East. That part of the range lying east of Mesaba represents roughly about one-sixth of the total area, yet a recent geological report states that if the reserves of the East Mesaba are to be considered as "available" at present" then "they will more than double the reserves of the range."

From Mesaba, which town is dwindling away, as a result of the depletion of the hematite mines in its vicinity, a single railroad track extends out over a hilly country, 15 miles away to the new El Dorado. Here at the northeastern tip of the range are 25 frame buildings, the temporary living and working quarters of 400 men. Several hundred yards away, in a straight line down a slope and facing the North are the foundations for the first unit. The steel framework for the plant is being erected and other material is on the site as well as some equipment for the crushing plant. A machine shop has been improvised and a power plant is being erected to replace the small temporary structure.

This, in brief, is Babbitt as it appears today, but the story of interest is not the precise stage at which construction is under way when it is moving along under competent hands, but in the broader view, the thoughts of the engineers as to their resources and reserves, their plans, means and mechanisms, and finally how it all fits with the established industry of mining and merchandising ore.

The logic in acquiring the deposits of the East Mesaba and beginning costly development work at a period when production of high grade ore is so easy, and output sufficient for the needs of the day is this: The Lake Superior district has the resources and must be for many, many generations the chief source of supply for that part of the American iron industry situated between the mountain ranges in the East and the Rocky mountains in the West. Chilean, Spanish and Swedish, and possibly Brazilian, ores may be brought to the United States and used by furnaces along the Atlantic, but under present conditions the ores cannot be transported commercially over the mountains and brought to the heart of the country. Mines may be opened up in the territories west of the Rockies, but similarly for reasons of transportation they cannot be marketed in the great central territory.

The proposed new water route from the Great Lakes to the Atlantic might seem to open the way for bringing to the lakes iron ore from the great beds in Newfoundland, but mining interests consider competition from this source as remote. Reserves have been discovered recently in the Hudson Bay district, with the possibility of development, but here again, weather and transportation difficulties weigh against it. These are possibilities, no doubt, to be considered "when the Lake Superior district approaches exhaustion," but the fact is that considered as a whole there is no sign yet of the exhaustion of the mineral wealth of the Lake Superior district. Big mines are becoming depleted rapidly, but reserves of high grade iron ore "in sight" actually are increasing on some of the ranges, while the tonnage of the lesser grades are measureless. With the principal market and mines thus in fixed relationship with one another, it becomes only a matter of experience and judgment on the part of the Lake Superior operators in selecting those properties which at the time promise to be the most profitable.

Estimating Reserves.

A considerable difference of opinion exists as to what are to be considered iron ore reserves, and before

a clear understanding can be reached the meaning of "iron ore" must be defined. The practical mining man of the Lake Superior district will speak of reserves as merchantable ore, conforming as mined with the prevailing market standards, or capable of being mixed to conform with market standards, 55 per cent metallic iron in the bessemer and 55½ in nonbessemer. The operator in the Port Henry field from which ore is shipped as concentrates will have a lower standard in mind in speaking of reserves and the same is true in Alabama.

Bases of comparison are not uniform either in the United States or abroad; ore for which there would be a ready market in one district or country would not be suitable under the conditions prevailing in another. In some instances "iron bearing formation" as understood and estimated by geologists is confused with merchantable supplies as interpreted by the mine operator. This same confusion exists among the mining men of the Lake Superior district. The operators or owners understand that there are at least 2,450,000,000 tons of standard iron ore in the ground and call these reserves. At the present rate of consumption these reserves are sufficient to supply the market for 40 years. On the other hand, in estimating reserves some geologists include all low grade ores and iron bearing formation and place the figure as high as 30,000,000,000 and more, "enough to supply the world for 1,000 years." The iron bearing formation in the Lake Superior district is so vast that the foremost geologists will not attempt to estimate the tonnage contained in it.

Operators know that for each drop of 10 per cent in the proportion of metallic iron, billions of tons will be added to reserves as calculated by operators in future years; but for them it is idle to speculate as to the tonnage or in what year all of it will have vanished. The means at hand for utilizing the low grade ores will in a large measure determine what are to be considered as reserves at successive stages in future developments. In the operators mind "reserves" are linked inseparably with taxes, and taxes are charged only against iron ore marketable at the specific period.

Reserves of marketable ore in Minnesota amount to about 1,700,000 tons, which includes the wash ores, but not magnetites. Reserves in Michigan and Wisconsin probably amount to 750,000,000 tons. This is a much higher figure than generally assumed, but is based on sound geological reasoning. The deepest levels to which the leading mining companies have worked recently have disclosed great tonnages, and the maintenance of known reserves at a constant level in Michigan despite shipments is one of the most important features of interest in the whole district. Michigan's known reserves have been increasing during the past few years in greater proportion than Minnesota's, indicating the value of the underground properties and that they are to become more depended on for supplies in the future. A recent report on the investigation of the magnetite deposits of the East Mesabi issued by the geological survey, University of Minnesota, states: "A rough calculation indicates that the East Mesabi range from Birch lake (Babbitt) to Mesabi contains about 1,500,000,000 tons of this magnetic formation within 100 feet of the surface without any bed rock cover. If such a reserve is to be considered as available at present it will more than double the present reserves of the range."

Reserves of low grade magnetites, averaging from 25 to 30 per cent iron, evidently are compared with about 1,300,000,000 tons of high grade merchantable iron ore of the western end of the Metabi, as estimated by the Minnesota tax commission. It is pointed out that "if the lean bodies of wash ores of the West Mesabi are to be included, these magnetic ores may well be added also." According to this the reserves "available at present" of the Lake Superior district would be 4,000,000,000 tons, instead of 2,450,000,000, the added tonnage being that contained in the East Mesabi.

The magnetic ore body of the East Mesabi extends down to an average depth of 400 feet with an average iron content of from 20 to 25 per cent, and therefore the reserves of iron formation in this body may be roughly calculated as 12,000,000,000 tons. The point of difference, however, is that in the latter instance 20 or 25 per cent ore is set up against an average 55 per cent ore, and the comparison fails. If all the ore of a similar low grade contained in the West Mesabi were taken into consideration the East Mesabi would by no means double that figure. The comparisons are only interesting as showing what resources in crude material the East Mesabi Iron Co., has with which to work, the company owning practically all of the deposit.

If its effort to commercialize the magnetites are successful it will then be but a step to commercializing the lower grade hematites by similar means. It is well known that hematite may be converted to magnetite through the process known as magnetic roasting, which consists simply of heating the ore with a small percentage of fuel when oxygen is driven off and hematite is changed to magnetic oxide. This process is not in use on a commercial scale, but it might readily become so if magnetic separation is proven to be of financial worth. At present the lean hematites, containing from 35 to 40 per cent iron are useful only for mixing with the higher grade ores, and when the latter are depleted concentration will be imperative. That is why so many companies owning or operating properties on the West Mesabi are deeply interested in the East Mesabi venture.

Difficulties to be Overcome.

While the magnetites of the East Mesabi were the first to attract the attention of explorers on the range, in the 60's, the subsequent discovery of the richer ores further west led to abandonment of interest in the East. Geologists, however, became well aware of the character of the magnetite formation, and at various times mining companies sank drills, concluded that mining would be impracticable, and withdrew.

The Lake Superior district proved to be such a wonderful storehouse that these mining companies could see no advantage in experimenting. However, while their attention was focused almost completely on their own properties, a mining explorer in Duluth, George St. Clair, now 73 years old, working in the field over a perid of 25 years, gradually acquired control of the greater part of the eastern range. He persistently sought to interest some of the old established companies. As time went on the East Mesabi was punctured with drill holes; mining companies understood thoroughly what was in it, but were not willing to incur the risk involved.

The ore could not be handled as are the richer qualities of magnetites found in the Port Henry district,

which do not have to be ground to a fine powder as a preliminary to obtaining a high-grade concentrate. Certain additions and refinements were necessary. This would be an open-pit project; open pit mining is limited to about six months of the year; the overhead charge on an idle plant of the capacity required would be enormous, even if magnetic separation itself were satisfactory. All the advantages and obstacles were considered, but not so minutely or in the light of the experience it remained for other men to bring to the task.

D. C. Jackling, the engineering genius of the Utah Copper Co., Copper Co., an expert in the handling of low-grade ore, became convinced that the application to this low-grade material of the methods which made the so-called porphyry copper properties successful, would solve the problem. Experimental work was begun in 1915. Mining engineers went out to Argo, an abandoned lumber camp situated near Babbitt, from where they conducted their work on the range. Material was shipped to Duluth, put through a small mill and eventually 2,000 tons of concentrates were shipped to the Midvale Steel Co., which company later became financially interested in the project. Subsequently other shipments were made. Research progressed continuously and by the time the results were generally known, the interests here mentioned, together with Hayden, Stone & Co., had obtained control of 25 square miles, including not only the magnetic formation, but some of the outer fringe as well.

Coming down to the point as to how this raw material of the East Mesabi is to be mined, concentrated and marketed in competition with the other ores: In the development of an open pit mine stripping entails a heavy expenditure; on the East Mesabi comparatively little stripping is to be done and in large areas absolutely none. The deepest overburden is 9 feet, the average of all, two to three feet. Eliminating much of the usual cost for removing overburden and the fact that it owns the fee of the deposits which are to be first mined, the company starts with an advantage of about $1 a ton over the costs of mining in other open pits. However, this advantage is largely diminished by the fact that it must mine at least 2½ tons of crude material to produce one ton of shipping product. It is proposed to ship concentrates containing approximately 65 per cent metallic iron, with a phosphorus content of between .02 and .025, which at the current rate would command a price of about $9.31-, delivered at lower lake ports, in comparison with $7.80 for a ton of old range bessemer ore guaranteed to contain 55 per cent iron natural and allowance for the premium for low percentage of phosphorus. Freight unloading and insurance, figures up to $2.39, leaving $6.92. Similar charges amounting to $2.20 applying to old range bessemer ore reduce the corresponding figure to $5.50. The difference, $1.33, roughly may be allowed for the extra operation entailed in producing a ton of the East Mesabi ore. The comparison is made with the old range bessemer ore owing to the fact that it is commanding a higher price than the Mesabi base grade and it is nearest the market. The average cost of mining and shipping a ton of standard bessemer ore from open pit mines in 1919 was $4.26 with an average profit of 70 cents. Estimated cost figures on the East Mesabi project indicate that the company not only will be well within the margin necessary for competition, but profit will compare very favorably with, if not greatly exceed, that on the standard base grade.

One of the most important points to be considered in the cost question is this: The function of a blast furnace is not only to produce iron from ore but to eliminate waste material. This is made into slag in the furnace, an expensive method. The enterprise being undertaken at Babbitt aims at the elimination by cheaper methods, and at the mines, so that freight and handling charges are reduced to a minimum.

As stated, the chief difficulty anticipated by some of those interests which are watching the experiment is the continuous operation of the plant. The company, however, plans to overcome this by stockpiling during the summer months so as to equalize the supply and allow of operating throughout the winter. Another point raised by some mining men relates to the means of disposing of the waste from the mill. A large percentage of this will be discarded as hard waste rock of small, uniform size and will be shipped as a by-product for road building and railroad ballast.

The mining will be carried on with steam shovel after the usual manner, with some quarrying to be done in side hills with faces 40 to 60 feet high. The crude material will be conveyed to the mill on a standard gage railroad.

Description of Plant.

The first unit of the plant will be approximately 2,500 feet long and 66 feet wide with framework of steel erected by the Minnesota Steel & Machinery Co. and asphalt siding and roofing. In reality it will comprise six separate sections, suitably spaced to allow of the equalizing of supplies. The first section will contain a jaw crusher 48 x 72-inches, of special heavy construction, 340,000 pounds in weight, with a foundation area of 10 x 15 feet. It will have a capacity of 15,000 to 20,000 tons a day. It will crush the crude material, consisting largely of rock to 12-inch size. From this crusher the material will pass by gravity to the second, a 36 x 54-inch jaw crusher, weighing 224,000 pounds. In this it will be ground to 5-inch size and continue to pass by gravity to four gyratory crushers which will grind it to 2-inch size.

The next step in the process is to pass the material by belt conveyor to dry magnetic separators working with 72 x 20-inch rolls, reducing it to ⅛-inch size and discarding about 50 per cent of it as waste. This machine is known as the drum cobber and consists of a short belt conveyor 30 inches wide and 6 or 8 feet in length. The head pulley travelling at a speed of 200 feet per minute is equipped on the inside with stationary magnets. As the crude material comes from the rolls it is distributed evenly over the surface of the conveyor belt near the tail pulley. Reaching the magnetic head pulley, the nonmagnetic waste particles fall into one compartment while the magnetic particles cling to the belt and are carried around to the underside of the drum and there fall into a separate compartment. This type of machine is now in use in the handling of iron ore in the Port Henry district and elsewhere. In East Mesabi practice a shipping concentrate also could be taken out at this point, although not so desirable as it is purposed to make the finished product.

The next section consists of ball mills grinding the ⅛-inch material in wet condition to 100 mesh and passing it on to the wet magnetic separator. This is of the Davis type, as designed, built and tested in the

laboratory of the Minnesota school of mines experiment station. It is similar to an ordinary log washer in construction with the exception that to the bottom of the tank is attached a series of magnets. These magnets hold the material to the bottom of the trough where the action of the logs forces the settled ore up a slope and delivers it as a clean concentrate, while the nonmagnetic material is kept in agitation and is washed over the rear end of the machine as tailing. The machine is simple and economical in operation, while the wear on the logs is much less than in ordinary log washers, due to the fineness of the particles of ore which are treated.

The remaining unit of the mill consists of the sintering machine, fusing the product into a clinker having the structural appearance and size of coke. Some of the iron in this sinter will be hematite and some magnetite, the percentages being varied according to the treatment on the machine.

In the sintering process, the fuel used is around 4 to 5 per cent, of the weight of sinter produced. Coke breeze, anthracite dust, bituminous dust, or fines from any source can be used, such as dock sweepings. The time for sintering runs about 20 minutes, depending somewhat on the depth of the charge used on the pallets. The sintering machine has a rated capacity of about 500 tons per day.

Where the sintering process to be used differs from the methods in ordinary use is in the introduction and mixing of the fuel. This is done while the concentrate still is fluid, before it goes to the filter, thus greatly reducing the investment and operating cost. This is a patented method which was demonstrated to be of practical worth in the company's preliminary experiments.

The percentage of phosphorus is under close control in the washing process. The sinter carries only traces of sulphur and titanium with silica between 6 and 10 per cent and alumina, lime, magnesia and manganese each below 1 per cent of the entire product. As tried out in a furnace practice by the Midvale Steel Co., it is said to have reduced the consumption of coke while increasing the productivity of the furnace.

The power plant will consist of four Edgemore boilers in conjunction with two General Electric turbines of 2,000 kilowatts each, while a complementary of the plant will be a machine shop for the handling of general repairs.

Build Town as Well as Plant.

Simultaneously with the work done on this first unit it was necessary to build living and working quarters, as well as a considerable amount of railroad trackage, eight miles of which are owned by the company. The town was situated on the crest of a granite hill and much of the two miles of water pipe was exposed, so that it became necessary to run a steam pipe along part of its length to prevent freezing in winter. W. G. Swart, the general manager of the company, lives in a cottage at the camp; there is a school for the children and comfortable quarters for all. As the mining enterprise develops Babbitt may rival some of the larger towns of the range. A permanent site is to be chosen a short distance from the present location.

The ore to be shipped from Babbitt will be handled through some established selling agency. Now that the future outlook is encouraging the inevitable reports, and conjectures as to what is to become of Babbitt and who eventually is to own or control are heard everywhere on the ranges. The most common comment is that Hayden, Stone & Co., are financiers, and not iron miners or furnace operators and that some large consuming interests whose own supplies are not in keeping with its consumptive demand must take it over. Be that as it may, some of the leading interests are known to be in close touch with the developments; they express the desire to see the project succeed. "It is a wonderfully big undertaking," they say, so big, in fact, that if it develops in accordance with expectation there would be but one or two companies so situated that they could handle it.

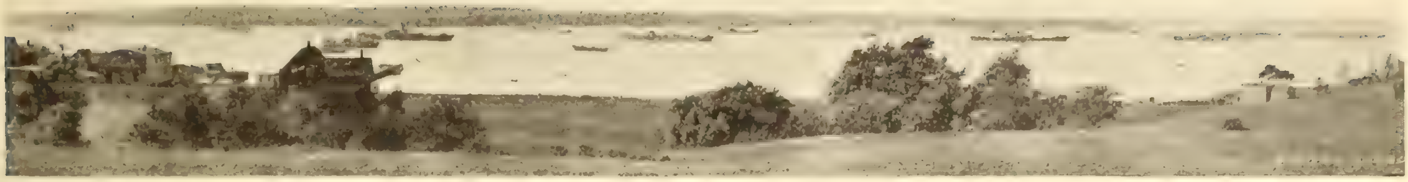
BOOK REVIEW.

THE UNIVERSITY IN OVERALLS—A Plea for Part-Time Study, by Alfred Fitzpatrick, Principal of the Frontier College. Toronto. With introduction by Dr. W. L. Goodwin, Queen's University, Kingston.

From personal observation of the work of the instructors of the Reading Camp Association (now the appropriately-named Frontier College) the Editor can pay tribute to its value. During troublous years, when employers of labor looked with just suspicion on things that savored of propaganda and that might conceal hidden and malign motives under fair pretenses, the college-trained youths who act as instructors of the Frontier College in their unique educational mission in the remote lumber, mining and construction camps of our frontiers of settlement, have steadily won the favour of employers and workmen. The daily life of the Frontier College instructor is no bed of ease. He must work all day with those who are his pupils in the long evenings; and in direct social contact with the workers and the self-supporting character of the instructors, the work of the Frontier College in the field of education is not unlike the work of the Salvation Army in relation to more conventional forms of religious effort.

Mr. Fitzpatrick's new book, "The University in Overalls" suggests that the clearing of bush-lands, the removal of liability to forest fires and summer frosts by extensive clearing and cultivation of such territories as the "Clay Belt" of Northern Ontario, should be made a department of organized national effort, and should not be slowly effected by the solitary toil and hardships of individual settlers, or by men gathered into camps as in wartime and separated from the society of women and family life. He suggests the creation of "clearing communities" where workers could live in small townships. This suggestion is not made to provide an outlet for immigration, but to relieve the pressure on the cities. "Clearing and cultivating the land is the only profession in Canada that is not crowded". writes Mr. Fitzpatrick.

It is in Mr. Fitzptrick's suggestions for enlargemen of the work of the Frontier College that his book is most helpful, and, so far as the mining industry is concerned, mine companies and superintendents will make no mistake, and will reap much benefit if they will co-operate with Mr. Fitzpatrick and his workers — good, clean boys, headed by a man of real vision who is doing very much for the Canadianizing of our foreign-born citizens and thereby stopping at its origin much possible future political and social trouble in this country.



SHIPBUILDING

A MARITIME METROPOLIS.

By A. R. R. Jones (In "Journal of Commerce of Canada.")

Canada is a land of great distances. It is natural, and not merely natural but fitting, that, in such a land, the minds of the people should be intent on the problems of transportation and transportation facilities. The Harbor of Montreal is alike a proof and a product, at once splendid and significant, of the virility and vitality of this young country. And the extent to which the successful solution of the transportation problem in Canada is dependent on the successful development of this Harbor is becoming more generally recognized today than it was but a very little while ago.

Situate 1,000 miles from the sea, Montreal is the furthest inland port in the world. It is the strategic point where ocean and inland navigation meet, and thus, almost automatically, draws to itself the waterborne commerce of the Lakes. It is approached from the sea by a ship channel, which will shortly be of a minimum depth of 35 feet at low water and of 750 to 1,000 feet in width, this channel being, as has just been pointed out, 1,000 miles in length. It is linked with a canal and lake system of inland navigation of 1,600 miles, extending to Chicago and Duluth into the heart of the North American Continent. It is nearer Europe than any other large Atlantic port.

The Present Harbor Commission.

The Harbor limits comprise 16 miles of water frontage on each shore of the St. Lawrence River. Every foot of this is owned by the public and administered by a Harbor Commission appointed by the Dominion Government. The president of the Harbor Commission is Mr. W. G. Ross, and the other members are Mr. Farquhar Robertson and Brig. Gen. A. E. Labelle. In their work of administration, the Commissioners have a free hand. They make their own plans, engage their own employees, and under their own departments the work of development and improvement is carried out. Every three or four years, Parliament votes the Commission a certain sum of money for the carrying out of such work. This money is voted on the recommendation of the Minister of Marine and Fisheries, to whom, each spring, the Commission submits its program of construction for the year. Mr. M. P. Fennell, Jr., is secretary-treasurer of the Harbor Commission; Mr. F. W. Cowie, M. Inst. C. E., chief engineer, Sir John Kennedy consulting engineer, and Capt. T. Bourassa harbor master.

It is fitting that the Harbor should be the property of the Dominion Government as trustees for the people of Canada. For the St. Lawrence, the great national waterway, is the heritage of the Canadian people. The St. Lawrence today carries to and from Montreal Harbor one third of the country's national trade, amounting to something like \$800,000,000 in value. In point of volume of trade, the port of Montreal is second only to New York on this continent. And it must be remembered that it is only open for trade for 7½ months in the year, while New York is open for 12 months. It must be remembered, further, that the population of Canada does not exceed 9,000,000 while that of the United States is over 110,000,000. As was pointed out, the other day, in this series of articles, the present Harbor of Montreal has cost the people of Canada less than \$30,000,000. It is an indisputable fact that no other country in the world possesses a port of anything approaching the same value that has cost it so little as the Harbor of Montreal has cost Canada. Moreover, that Harbor is one of the comparatively few publicly owned and operated utilities on this continent that pays its way. The money which the Government pays out for improvements is advanced on the security of debentures of the Harbor Commission. These debentures are issued for a period of forty years, and a sinking fund has been established to provide for them on maturity. This sinking fund is being built up out of revenue. In addition, the interest charges are also, of course, paid out of revenue.

A Truly Napoleonic Conception.

It has been well said that the successful port of today requires not only imports and exports, but also industrial enterprises. Unless it has been shown that Montreal possesses this quality in abundant measure, the articles immediately preceding this have been written in vain. But the project is far more than merely local, it is of the utmost national, importance. The scheme of development which is being carried out in Montreal today holds potentialities that are almost illimitable not only for the great commercial metropolis but for the Dominion of Canada itself. Necessarily the war retarded the carrying out of this scheme of development. For while the war was on, the construction program was considerably modified at the request of the Minister of Marine and Fisheries. In fact, only those facilities that were absolutely necessary were proceeded with. All construction work that could possibly be postponed was postponed. Indeed, during the war, the Harbor Commission's entire construction forces were converted into operating. Immense demands, for the shipping weekly of troops by trainloads and material by the hundred thousand tons, were made upon the Port of Montreal. And it is a source of no small pride to those responsible for the conduct of this vast business that not once was the Port unequal to the demands made upon it.

When the development scheme now in process of being carried out is completed, it will double the size of

the Port of Montreal and will give it over 10 miles of continuous pier and wharf frontage, together with the most modern transit sheds it is possible to build, a cold storage warehouse and electrified terminals, etc. As Mr. M. P. Fennell, Jr., the secretary-treasurer of the Harbor Commission, well said, in the course of an address before the American Association of Port Authorities at Galveston, little more than a year ago: "There is something Napoleonic in the conception of a well equipped seaport one thousand miles from the sea, almost in the heart of the continent, yet one whose steel and concrete piers and freight sheds, whose network of tracks of the belt-line, whose effective system of grain elevators and grain conveyers for the easy loading of rail and ship borne cargoes, are all linked with the sea by a ship channel so perfectly lighted all the way to Montreal that ships may navigate it at night with less peril than a 'Twin-six' navigates Broadway."

Electrification of Port Railway.

It was mentioned, three weeks ago, that Montreal Harbor provides 100 steamships berths from 350 to 750 feet in length, with a depth of water from 20 to 35 feet. Thirty-five of these steamship berths, it should be added, are modern concrete wharves, built in the past few years.

In the nature of things, one of the chief—perhaps the chief—problem to be solved at Montreal Harbor, in connection with transportation, is a terminal problem. On the efficiency and capacity at the terminal points the growth and progress of the Harbor, and of the St. Lawrence route which it serves, must largely depend. For it is at these terminal points that cargo is collected and distributed. To the importance of this terminal problem the Harbor Commission is fully alive. The Harbor Railway Terminals, consisting of surface lines between Victoria Bridge and the Wharf of Imperial Oil, Ltd., have a total trackage of nearly 60 miles. It was resolved to electrify this railway system, in view of the climatic conditions, and having regard to the fact that electrification for freight yards and terminals has proved both economical and, in other ways, satisfactory elsewhere. Accordingly, a start with this work was made in September, 1919, and it is now well advanced. The work itself is being carried out by the Electrical department of the Harbor Commission, the material being purchased from outside, and is divided into four main sections, namely (1) power station machinery equipment, (2) control, protective and signal equipment, (3) overhead catenary line equipment, and (4) rail bonding material.

Large Modern Fireproof Elevators.

Montreal Harbor contains three large modern fireproof elevators. Of these two—with capacities respectively of 4,000,000 and 2,662,000 bushels—are operated by the Harbor Commission itself. The third elevator with a capacity of 2,150,000 bushels, is operated by the Grand Trunk Railway. These elevators are situated in the most advantageous position in the Harbor. The two operated by the Harbor Commission itself are connected with each other and serve a system of grain conveyors by means of which grain can be delivered to ocean vessels lying at their berths, eleven different ships receiving grain at the same time at the rate of 15,000 bushels an hour and without interference with the handling of general cargo. The Harbor Commission also owns several floating grain elevators for taking grain from lake vessels, or canal boats and loading it directly into ocean steamers. In short, Montreal is unique as an ocean port in its grain handling facilities, and its elevators are probably the best of their kind in the world. Of the two elevators belonging to the Harbor Commission, one is 530 feet long, 128 feet wide, and 202 feet high, while the other is 457 feet in length, 100 feet in width and 220 feet in height. The first is the largest seaport elevator in the world. The second is the first large terminal elevator building constructed entirely of reinforced concrete.

Permanent Fireproof Transit Sheds.

Altogether there are twenty-five permanent fireproof transit sheds in Montreal Harbor. With the exception of four, they are double deck sheds of uniform design, having a width of 96 feet and a length varying from 400 to 650 feet. They are of steel construction, with floors and roofs of reinforced concrete, and walls of corrugated iron sheeting. There are two rows of columns down the centre of the sheds, spaced about 16 feet longitudinally.

There are three dry docks, two of which are small graving docks, while the third is a large floating dry dock with a lifting capacity of 27,500 tons. For handling heavy freight, a large floating crane was installed as an adjunct to the Harbor in 1909, and this has proved a most valuable utility. This crane has a lifting capacity of 75 tons at a 54 feet radius. In the season of 1908, which was its period of greatest activity, it lifted a total weight of 18,555 tons. Ordinary cargo is handled by the winches and cargo booms of the steamships.

Large Cold Storage Warehouse.

The Harbor Commission is proceeding with the construction of a very large cold storage warehouse. Work on this is already so far advanced that it will be ready for use in this year's season. It will be administered and operated in the same way as the public grain elevators. Its cost will be, approximately, $1,500,000. The necessity for this big work was threefold. First, it was the experience of importers that, as there was no public bonded warehouse in Montreal Marbor, importation of stocks, when prices were favorable and ocean transportation possible, was not feasible. Secondly, it was found necessary, from the point of view of the Harbor Commissoin itself, to provide for the storage of imports which obstructed business in the sheds. Thirdly, warehouse space was required for Canadian manufactured goods shipped from factories interior to Montreal Harbor, and to be held until transportation conditions and a market abroad are favorable.

The building which is immediately inside the Harbor retaining wall at the foot of Beaudry Street, is of an irregular, rectangular shape, fronting the St. Lawrence River, and, when completed, its outside dimensions will be 436 feet by 103 feet. It is to contain eight floors and a basement. The whole of the interior of the building is to be of reinforced concrete, the floors being supported entirely independently of the surrounding walls, while the walls are of reinforced concrete framework and pilasters with brick and hollow-tile filling. At first, only four walls will be insulated and refrigerated, the remaining space being used for "dry" or general storage. The warehouse is to be equipped with eight large freight elevators and one passenger elevator. Each cold storage floor is to be divided into nine rooms, varying in capacity from 77,750 cubic feet to 35,750 cubic feet, and all opening on to a spacious, well-lighted distributing corridor. Special attention is to be paid to the ventilation and

purification of the air, this being provided for by means of a scientifically designed air-conditioning plant. The whole of the cold storage floors will be refrigerated by means of the circulation of calcium chloride brine through pipes and coils in the rooms, the brine being previously cooled to a very low temperature in the Power House which, in addition to the electrical equipment for the operation of the Harbor Electric Railways, contains the necessary mechanical refrigerating equipment.

Of the need for a large, modern cold storage warehouse of this kind in Montreal Harbor, there can be no doubt at all. For one thing, as the Harbor Commissioners point out in their last Annual Report, while the Harbor is closed to shipping, on account of weather conditions for five months in each year, the produce of Canada and the demand therefor from Europe continue during the whole year, and it is essential that such produce, if intended for shipment from Montreal, should be stored under proper conditions until navigation reopens. For even during navigation periods, a cold storage warehouse is essential in order that perishable goods may be safely held for such length or time as may suit the sailings of the ships. It is anticipated that not only will this cold storage warehouse be productive of revenue as a storage plant, but also that its operation will result in extra shipping, which hitherto has availed itself of United States ports for the produce business, now making use of Montreal instead.

No Privately Owned Areas.

No private interests have any strings on Montreal Harbor. This is a very different state to that which obtains in the case of nearly all the large ports in the United States. In Seattle, for example, the railway companies actually own certain portions of the harbor, and in Boston one of the best piers was, at one time, leased by a railway company. But within the jurisdiction of the Montreal Harbor Commission, namely sixteen miles of water front on each side of the St. Lawrence, there is not a single vested private or corporate interest of any kind. "Nobody," said Mr. Fennell, in the address above quoted, "can build a warehouse, an elevator, or a pier; nobody can lay a rail or rent wharfage space except with the sanction of the Commission. Even the great railroads of Canada have their privileges apportioned to them in Montreal, with the result that, in the enjoyment of the Harbor facilities, no one corporation is permitted to monopolize equipment to the exclusion of others. Every railroad is afforded access to the Harbor upon equal terms throughout its entire length as also to the industries along the water front adjacent to the Harbor railway tracks." In short, the Harbor of Montreal is operated on an equal and democratic basis. It is operated, it should be added, for the benefit of the entire Dominion and not with the object of making a big profit.

Twenty-one Different Lines.

In 1920 the total tonnage of trans-Atlantic shops entering the Port was 2,020,519, as compared with 2,043,638 in 1919. Passenger traffic was exceptionally heavy in the season of 1920. Today there are trading from the Port of Montreal to almost all parts of the world deep-sea ships of no fewer than twenty-one different lines, including the best-known lines in the world, and not least important the Canadian Government Merchant Marine whose rapid development means so much in the present and augurs still more for the future.

BOOK REVIEW.

THE HUMAN FACTOR IN INDUSTRY: By Dr. Leo. K. Frankel and Dr. Alexander Fleisher, respectively Third Vice-President and Assistant Secretary of the Metropolitan Life Insurance Company, with the co-operation of Laura S. Seymour. Cloth Boards. 5½ by 8 inches 366 pp. with list of references and Index. Price $3.00. Published by the Macmillan Company of Canada, Toronto.

This work is designated to be used as a text-book in service and personnel management technique. The arrangement of contents is by subject and not by industry, in itself a commentary on the growth of literature of this class. Interpolated throughout the chapters are numbered references to the literature on the subject under discussion, which, as the chapter deal with such subjects as "Hiring & Holding", "Education", "Refreshment & Recreation", make the collected references appended to the volume a reasonably good selected bibliography.

Under the significant heading of "New Names for Old", is is pointed out that the responsibility of the employer for his workmen, or to use now archaic terms, the solicitude of the master for his man, was fully realised under the guild organizations of medieval industry. Later submerged by the dominance of the machine, we are today re-discovering forgotten duties and giving them a modern paraphrase. The authors query why the value of human labor has been more appreciated in the past decade than in former years of machine industry, and while they state that no one reason can be given, they give a number, the resultant of which appears to be that neglect of the individual has been found not to pay.

The work throughout does not stress the religious or altruistic side of human dealings, but explains that in the last analysis the value of this factor in industry will be measured by the employer in terms of increased production, and, by the employee, by the opportunities which are accorded to him for personal development, both financial and spiritual. In short the yardstick will be: "Does it pay? Is it worth while?" This is putting the matter in terms of lowest denomination, but also in terms of final and permanent expression. It is this dispassionate treatment, backed by definite instances of successful application, that gives this book its value.

As a handbook to officers of industrial corporations, engaged in personal work, it strikes us as a most valuable compilation, and it contains definite information on such subjects as housing, technical and part-time education, food catering for employees, insurance, sickness, death, and other benefits, charts on the organization of employment departments and medical services, and, as previously stated, a satisfyingly complete bibliography.

One penetrating phrase we may quote from the book, dealing with development of the employee, once he has been hired and inducted into his work, is that "a careful policy of promotion makes of the employee's personal ambition 'a centripetal instead of centrifugal force' in the industry". The secret of the success of many well-known executives of industry lies in their appreciation of this principle.

Electric Power Replaces Steam on Large Reversing Blooming Mill

By B. M. Jones, General Engineer, Westinghouse Electric & Manufacturing Company.

For the first time in the history of the American steel industry electric power has replaced steam on a large, reversing, blooming-mill. Only two previous installations have been made in other countries to change from steel to electric power, and in one case, the steam engine was left intact for emergency purposes.

On December 7, 1920, the huge steam engine driving the 44 inch reversing blooming-mill of the Steelton plant of the Bethlehem Steel Company, broke down. Work was started immediately to tear down the engine which, as had been previously planned, was to be replaced by electric drive. On December 31, the Bethlehem Steel Company started to roll steel with the new electric motor. Considering the tremendous task of tearing down the large reversing steam-engine, blasting out its foundations, building the forms for the motor foundations and installing the complete electrical apparatus in working order, the time taken, only twenty-four days, is remarkable.

Inasmuch as the blooming mill is the only one in the plant, it was important that the change-over to the electric drive be made in the shortest time possible. In addition, it was also important that no time be lost in making adjustments or in tuning up a new equipment. To accomplish this, it was necessary to have everything well organized and planned in detail, so that there would be no unnecessary delay. The forms for the reversing-motor foundation were built up complete in two pieces as a template before the engine was removed, and after the old foundation was blasted out, these templates were set in position, the foundation bolts placed, and the concrete immediately poured. This materially shortened the time required to make the change.

The motor rolled 609 tons of steel the first day, 796 the second, and 1006 the third. The mill is now operating single turn, and is in no way curtailing the output in spite of the fact that because of shortage of power, under the present condition, it is necessary to operate the equipment with a power demand not exceeding 2500 kw.

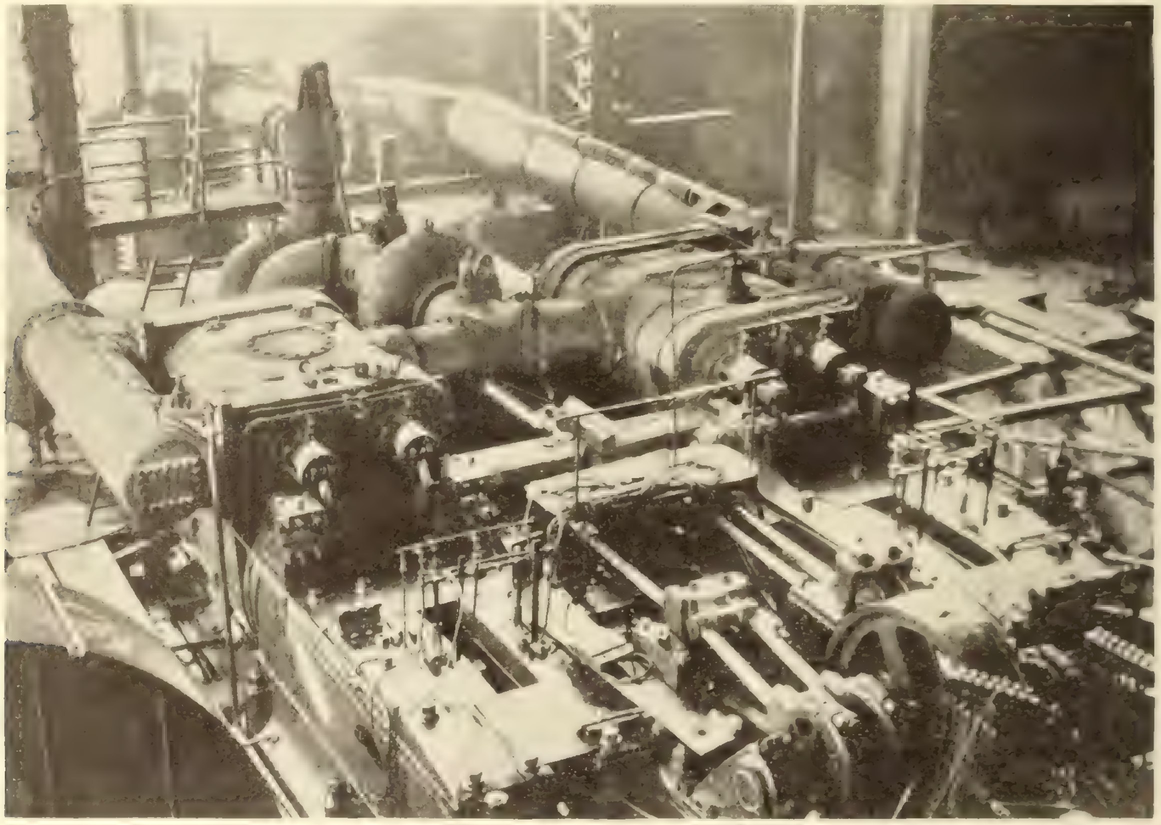


Fig. 1. Twin, tandem-compound, reversing steam-engine 36" and 60" by 54" which was replaced by electric motor at the Steelton Plant of the Bethlehem Steel Company.

The electric drive consists of a double-unit reversing D.C. motor, the necessary flywheel M.G. set for driving it, and a small exciter set, together with a blower outfit and the necessary switching equipment. All the machines except the blower outfit are mounted on the first floor of the motor room sub-station. The blower outfit is mounted in the basement and the switching equipment is mounted on a balcony. Lightning arresters are installed on the second balcony.

The double-unit reversing motor, as shown in the illustration, is a 600-volt, adjustable-speed, direct-current machine of the compound-wound, compensated type, having a speed range of 0 to 120 R.P.M. in both directions. It is capable of developing 1,900,000 ft. lbs. torque momentarily and is directly connected to the mill.

Each armature of this motor is mounted on the forged-steel shaft, which is supported by two pedestal-bearings arranged for water cooling and gravity oil-lubrication. The bearings and frame of the motor are supported by a heavy cast-iron bedplate, which is well anchored to the concrete foundation by long foundation bolts.

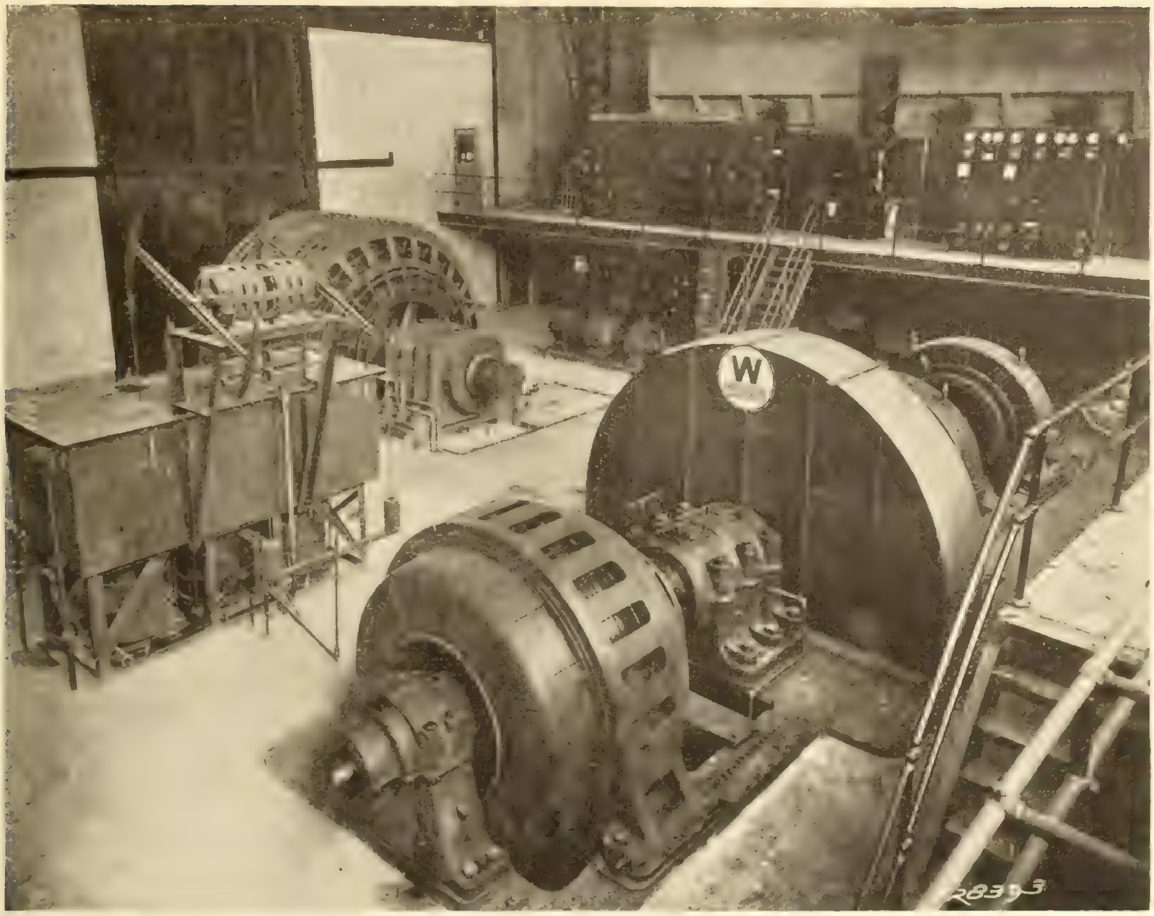


Fig. 3.—A view of entire motor-room substation. Note the difference between this illustraton and Fig. 1, which shows the old steam-engine. Only twenty-four days were required to bring about this change.

The motor is semi-enclosed and is arranged for forced ventilation. The blower equipment, installed in basement, is interlocked so as to prevent operation of the reversing motor in case the blower is not delivering the proper amount of air to the motor.

Electrically and mechanically the motor is designed to withstand the overloads encountered in reversing blooming-mill service, and in addition, it is provided with a large thrust-bearing on the pedestal nearest the mill to protect it from the mechanical shocks of the mill, such as the breaking of a spindle. The ease and rapidity with which this motor can be started, stopped and reversed, shows it to be inherently adapted to reversing blooming-mill service.

The motor is a compound-wound machine, the compounding being obtained indirectly by means of a small series-exciter and a separate winding on the main poles of the reversing motor. Due to the extremely high-peak currents, encountered in the main circuit, it would be extremely difficult to reverse the ordinary type of series-field which would be necessary to keep the proper shunt and series-field relation.

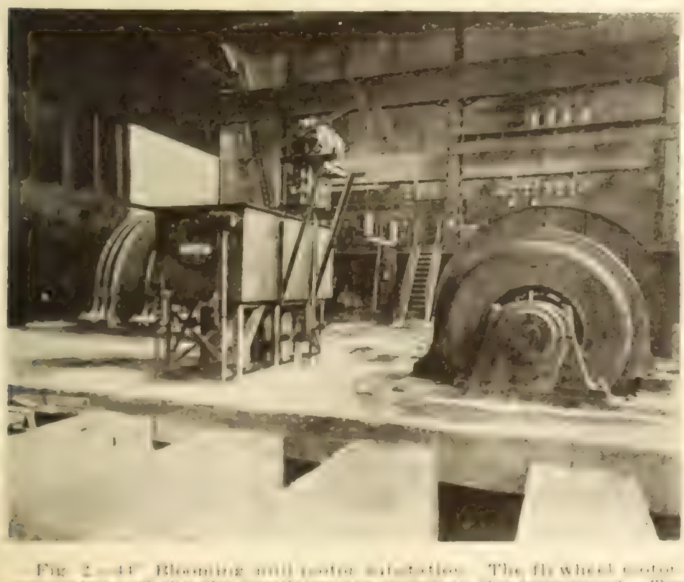


Fig. 2.—44" Blooming mill motor substation. The flywheel motor generator and the slip regulator are shown in the foreground. The switch-board and control panels may be seen in the background.

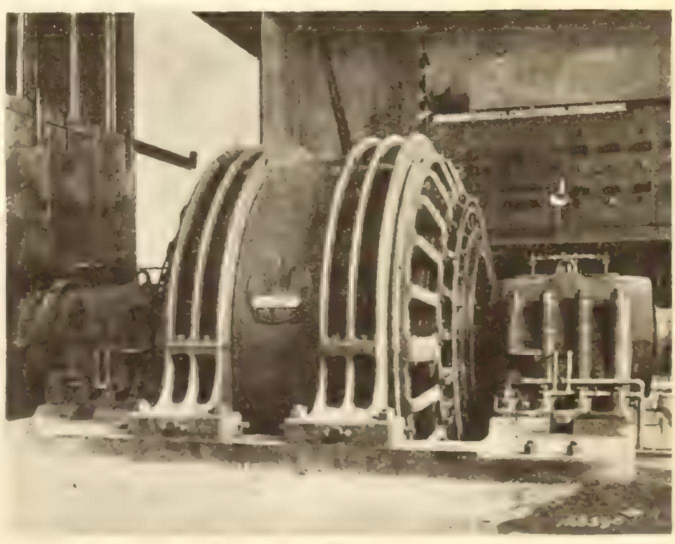


Fig. 4.—Side view of the large 44" reversing blooming mill motor.

[illegible] and the separate-field winding is used, the series-exciter field being connected in series with the main-motor armature circuit, and the armature of the series-exciter being connected across the separate winding of the main reversing-motor.

The switches for reversing this field are operated from the master switch, which also operates the reversing switches in the field of the generator. By this scheme, the compounding effect is obtained without the necessity of reversing the heavy armature current. This compounding of the reversing motor allows it to increase its torque on the overloads, and thereby better meet the severe shocks that are encountered.

Construction Features of Flywheel Motor-Generator Set.

The reversing motor receives its energy from two 600-volt, 367 R.P.M., separately-excited, shunt-wound, direct-current generators of the compensated type, which are designed to withstand the same peak-loads as the reversing motor. These generators are driven by a 3200 hp. alternating-current motor of the wound-rotor type, which is designed to operate on a 3-phase 6600 volt, 25-cycle circuit. A 100,000 lb. flywheel is mounted on the same bedplate between the motor and generators. This flywheel is completely enclosed with a plate cover to reduce the windage losses, and also to afford protection to the operator. The flywheel bearings of this set are arranged for gravity lubrication and for water cooling as an emergency feature.

Operation of Liquid Slip-Regulator To Control Input to the Flywheel M.G. Set.

A liquid slip-regulator limits the peaks and equalizes the input to the flywheel set. When the load on the alternating current motor reaches a predetermined value, the regulator introduces resistance in the secondary of the induction motor which causes the flywheel set to slow down, thereby allowing the flywheel to give up a portion of its stored energy, and thus absorbing the peak load. When the peak load goes off, the regulator cuts out the resistance in the secondary circuit of the induction motor, and brings the flywheel set back to aproximately full speed. The regulator is so arranged that the alternating-current motor cannot be started until the maximum resistance is inserted in the secondary by means of the slip regulator being wide open. The switching equipment of the alternating-current motor is so arranged that the flywheel set can be brought to rest within a short space of time by opening the forward, primary, oil circuit-breaker and closing the reverse, primary oil-circuit-breaker. This reverses one phase of the induction motor, causing it to exert a torque in the opposite direction, and thereby bringing the set to rest quickly.

Special attention has been given to the manner of insulating these machines to withstand the dust and dirt usually encountered in a steel plant. The direct-current machines were designed with the object of being able to withstand the severe overload encountered in this class of service. The rapid change of flux in the poles requires careful design to eliminate com-

Fig. [illegible] Flywheel motor generator set which furnishes power to the motor shown in the background.

mutation troubles from which these machines are particularly free. The design of machine to handle this class of service involves many wide departures from previous practice, and the exceptional service that these machines have given, is a very good indication that they are liberally designed to withstand the abnormally high current encountered.

Motor-Generator Control System Simple As Well As Effective.

The simplicity of this control equipment is clearly shown by the fact that the steam-engine operators rolled steel at the first trial without any trouble whatsoever. The operators seemed very well pleased and surprised to find the ease with which the master switch was handled and the ready and sure response of the motor to the master switch.

The control of the main motor and generator is obtained by the adjustment of the fields, the generator fields being reversed to obtain reverse direction of rotation of the main motor. The excitation of the motor shunt-field remains in the same direction at all times. The speed of the reversing motor is propor-

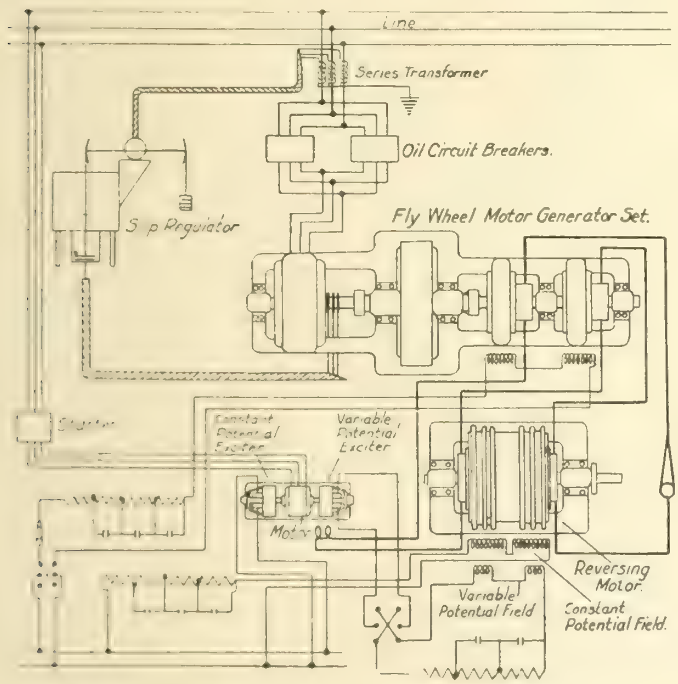


Fig. 6. Schematic diagram of connections for double unit, reversing mill equipment.

tional to the generator voltage up to normal voltage, and beyond that point the increase in speed of the reversing motor is obtained by weakening its main shunt-field. The compound field, described previously, is adjusted to correspond with the speed of the reversing motor. The master switch is mounted in the mill for controlling the contactors which adjust the various field circuits of the motor and generators. The position of the master switch determines the speed of the reversing motor, and its direction of rotation. This system of control makes the operation of the equipment extremely simple and very easy to operate while at the same time obtaining a very rapid and effective means of control. Fig. 6 shows the schematic diagram of connection for this equipment.

The reversing motor and direct-current generators are separately excited, receiving their excitation from a small induction-motor-driven exciter set. The main direct-current circuit-breaker between the reversing motor and its generators is so interlocked that it cannot be closed unless the exciter set is operating properly.

Additional Equipment in Blooming-Mill Motor-Room Sub-Station.

The motor-room sub-station is used for synchronizing the two powerhouses and there are installed on the first floor three—1000 Kva. transformers having a ratio of 2,200 to 6,000 volts, through which the power of one powerhouse is stepped up to the voltage of the second powerhouse. The oil switch and synchronizing apparatus necessary for synchronizing these two stations is located on the gallery. A double-feeder system is brought to the gallery from one of the power plants and usually these two feeders are used in parallel for supplying the induction motor of the flywheel M.G. set.

A small transformer 6,000 to 440 volts with a 220-volt starting-tap is used for supplying the power to the exciter-set, blower and pump motors. As an emergency feature, the Bethlehem Steel Company have brought the 440-volt A.C. mill-circuit into the motor-room sub-station. This circuit will be used for driving the exciter set, blower and fan motors, in case any trouble develops on the small transformer.

Ventilation of Motor-Room Sub-Station.

As a convenient and effective means of keeping some of the mill dust and dirt out of the motor-room sub-station, an additional, duplicate, blower equipment was installed in the basement and is arranged in conjunction with the other blower equipment, so that either blower equipment can be used to ventilate the room while the other is ventilating the reversing motor. This affords a considerable means of protection against dust and dirt settling in the motor room.

Future Additions to the Motor-Room Sub-Station.

This motor-room sub-station was laid out with the object of installing several motor-generator sets at some future date for supplying the D.C. power to the mill auxiliaries. At the present time these sets are not installed, but it is expected that within a year they will be in operation in this sub-station.

T. H. Watson & Company, Sheffield, England announce that arrangements have been made with the General Combustion Company of Canada, Ltd., New Birks Building, Montreal, to handle, build and sell their various electric smelting, melting and refining furnaces.

The Canadian rights for the "Greaves-Etchells" type of furnace, which has been widely adopted in U. S. A., England, Spain and France are also included in the arrangement made.

The General Combustion Company of Canada Ltd., also taking over the designs of the Electric Furnace Construction Company, Philadelphia, on the various types of electrically heated Core Ovens, Annealing and Heat Treatment furnaces and will have the active cooperation of the American Company on electric furnace problems generally.

An English exchange in a Reuter despatch from Ottawa, under the head of "Canadian Steel Companies" mentions that the L. R. Steel Co., Ltd., has increased its capital stock. This Company is not usually classed as a steel company on this side.

Importance of Hardness of Blast-Furnace Coke

By OWEN R. RICE,* Ch. E., Bethlehem, Pa.

A paper read at the New York Meeting in February of the A. I. M. & M. E. and reproduced by permission.

Changes in coke hardness affect the working of the blast furnace, for soft coke is an obstacle to proper furnace operation. Soft coke is due to a low hydrogen-oxygen ratio in the coal charged; increasing this ratio increases the hardness of the coke. The best means of determining the hardness of coke is the combined tumbler and ball-mill.

Soft coke is a great hindrance to proper blast-furnace operation and changes in coke hardness affect the working of the furnace. The best method of determining the hardness of coke is by using a combination tumbler-ball-mill. Soft coke is due to a low hydrogen-oxygen ratio in the coal charged. An increase of this ratio improves the hardness of the resulting coke.

What is Good Coke?

It is not always appreciated that the correct answer may be such a reliable forecast to the physical condition of the blast furnace, and incidentally its entire

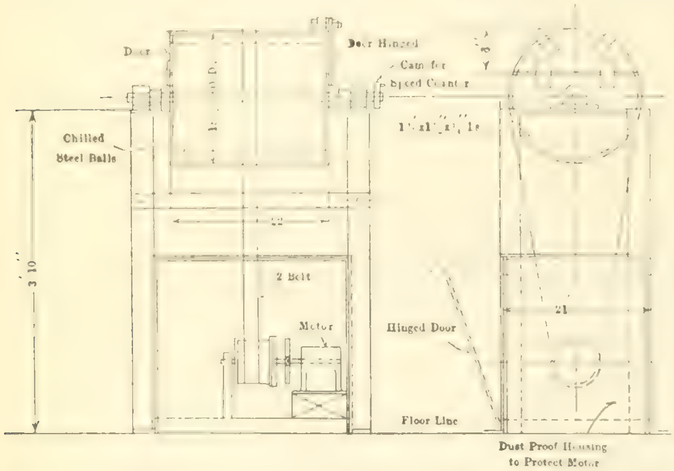


Fig. 1.—Apparatus used by Bethlehem Steel Co. to determine Hardness of Coke.

operation, that among the ordinary variations in other raw materials and also in operating conditions, it assumes a position of primary significance. Inasmuch as coke forms two-thirds of the total bulk of material charged, this assertion will not seem exaggerated, and in the subsequent discussion its applicability will be presented.

Coke is the ideal blast-furnace fuel because it is strong and hard enough to resist the crushing and grinding effects of the furnace burden, and its porosity allows the ready passage of gas upward through the charge, and rapid combustion before the tuyeres. Coke deprived of its strength and with a cell structure physically frail and chemically susceptible to solution by carbon dioxide, has its chief asset eliminated. When the melting zones are approached the fluid cinder trickling toward the hearth will envelope the small pieces of coke and form a sticky mass that will retard the free passage of gas. Blast pressure will then rise, driving will slow up and fragments of coke will lie inert before the tuyeres, rendered practically incombustible by their slaggy envelop. It is believed also that coke messes at cast are attributable to quantities of such coke floating unburned in the hearth.

It has been correctly claimed that coke rendered small outside the oven possesses greater combustibility than that so developed in the coking process. While this is true of reduction in size by ordinary breakage or shattering, where the porous inner cell structure is cleanly exposed, it does not hold true of coke that is ground small, for the grinding action causes the fine dust-like particles to enter the cells and so form a dense and quite incombustible surface.

Satisfactory Test for Hardness of Coke.

The importance of initial size and the resistance of coke to reduction in size has been recognized, but methods thus far employed to determine the physical nature of coke have not given full satisfaction. The shatter test, now largely employed, usually consists in dropping 2-in. coke (that portion of the original sample that remains upon a 2-in. mesh.) four times upon an iron plate from a 6-ft. (1.8 m.) elevation and then the screening through certain sizes of mesh, the various sizes thus separated being reported as percentages. This gives an indication of the condition of the coke when it reaches the furnace, having passed through the four major stages of handling; viz., cars to bins, bins to larry, larry to skip, and skip to bells.

But it must not be supposed that reduction in size ceases when the bells are lowered and the coke passes to the furnaces. It will continue and may even be accelerated throughout the entire passage from stock line to tuyeres. The gazes will endeavor to disintegrate the cell structure and the mass of stock will exert a destructive grinding and crushing effect. Therefore, while a shattle test may indicate the extent of size reduction due to handling, it does not show the condition of the coke when it reaches its field of action—the tuyeres. Indeed there is frequent misguidance if the shatter test is depended on to determine fit or unfit hard or soft—blast furnace coke.

If a shatter test shows high fragmentation, the coke may have a weak, chalky structure that will resist no physical strain and cell walls susceptible to carbon-dioxide solution; or the coke may be glass-like in its brittleness but strong enough to bear the grinding, crushing, and abrasion of the brickwork, limestone, scrap iron, etc., on the way to the tuyeres, maintaining throughout a size that permits it to function properly as a porosity medium and that precludes the likelihood of its being "drowned" in slag. The coke that resists shattering is either the tough, soft variety, which is sure to yield to the abrasive action later on; or it is the strong, hard kind that is not susceptible to any sort of physical attack. The need for a more reliable test is, therefore, quite evident.

The effort to apply a test that more closely follows the treatment of coke in the furnace was stimulated by the article of G. D. Cochrane in which he compares the results of a tumbler test on coke with the operation of a low-pressure furnace. In following his lead, we have used a combination tumbler and ball-mill to determine the hardness of daily coke to three 500-ton

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furnaces, D, E, and F. The bosh angles of the furnaces are 76°, 76°, and 73½°, respectively.

Our apparatus, shown in Fig. 1, is a 22-in. (56 cm.) steel drum, 18¾ in. in diameter with doors at either end and four 1½-in. angles riveted inside longitudinally. A ¼-hp. motor drives the drums at about 20 r.p.m., the belt passing from the motor gear train over the drum itself. Thirty pounds of dry 1-in. coke (that which passes 2-in. and remains on 1-in. mesh.) about half fills the drum. This sample is tumbled for 1250 revolutions (at 20 r.p.m.) with eleven 1¼-in. (32 mm.) steel balls. The resulting fines are screened through ½-in. mesh, and the remaining portion is weighed and reported as per cent. of original. This quantity is termed the coke hardness number.

The results of the regular shatter test are shown in Fig. 2 as "per cent. through 2-in. mesh," and after four 6-ft. drops upon an iron plate. The results of both the tumbler test and the regular shatter test were compared with furnace operation on each subsequent day when the coke tested was passing through the furnace. A period of two months was selected as typical of conditions at that time, being marked by irregularity both of raw materials and in furnace behavior. The hard ores, for example, varied in furnace D from 0 to 100 per cent.; in furnace E, from 0 to 20 per cent.; and in furnace F were fairly constant at 25 per cent. Tons of stone used per ton pig produced varied widely, the daily averages covering a range of 0.40 to 0.65 ton. The daily averages of scrap charged per ton pig produced ran from 0.08 to 0.35. Coke consumed per ton pig varied as much as 20 per cent. on each furnace. The

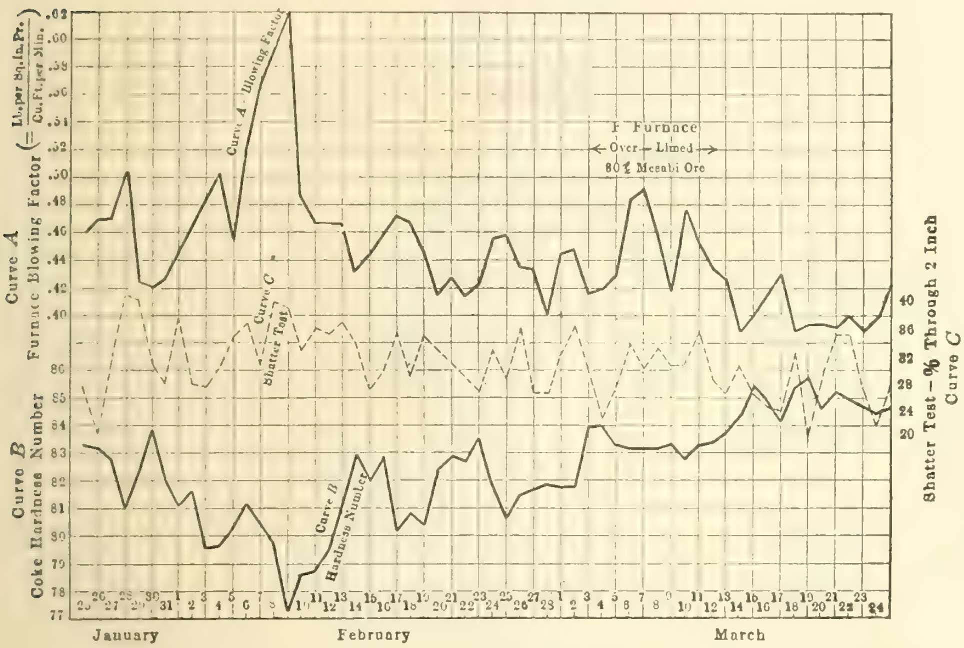


Fig. 2.
Relation of Furnace Operation to Coke Hardness.

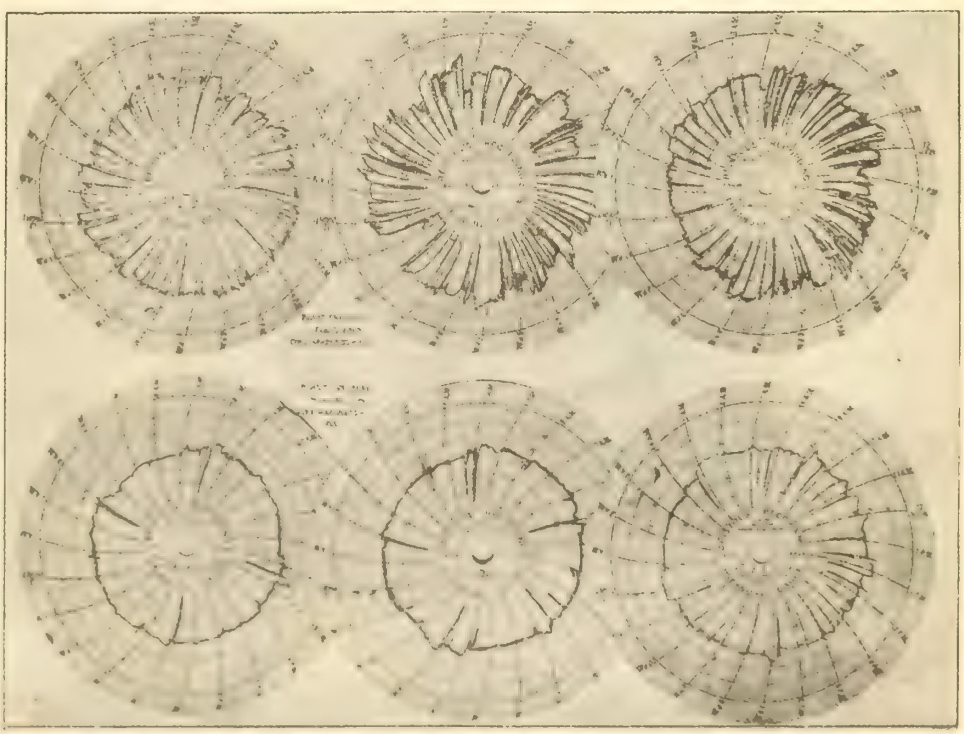


Fig. 3.
Pressure Charts showing condition of Furnaces with Soft Coke and with Hard Coke.

operators fought the wide variations in blast pressures that were constantly threatening, and maintained an average pressure of 17 lb. (7.7 kg.) for the period.

The blowing factor is simply the ratio between the blast pressure and blast volume:

Blowing factor=

$$\frac{\text{average blast pressure, lb. per sq. in.}}{\text{average wind blown, cu. ft. per min.}} \times 1000$$

In no way is the physical well being of a furnace so truthfully indicated as by the blowing conditions. The blast is the pulse of the furnace. Pressure and volume conditions must be considered simultaneously, however for the furnace may be driving well with pressures up to 18 or 20 lb. due merely to rapid blowing; or it may be hanging and slipping and may require slackening of the engines with but 14 or 15 lb. pressure. High pressure and low volume produce a high blowing factor and indicate poor working; low pressure and large volume yield a low blowing factor and show proper furnace conditions. As a matter of daily record, blowing conditions furnish more reliable data on the health of the furnace than either tonnage or rounds charged, both of which depend largely on the nature of the ores used or the size of burden; and both are affected by delays. Moreover, both tonnage and rounds charged, other conditions being constant, are direct consequents of blowing conditions.

The almost unfailing inverse coordination, day by day, between the hardness number and the blowing factor was enlightening, particularly in the face of the numerous operating irregularities that marked the test period. It was only between Mar. 5 and 10 when furnace F was carrying 80 per cent. of a Mesaba ore that has always caused trouble, that the furnace worked badly in spite of fairly hard coke. Hardness number was between 83 and 84 at the time. Cold stock reaching the hearth, due to heavy slips, led to off casts and large excess of stone was carried to curb the rising sulfur in the pig; this further aggravated high pressure conditions.

The two sets of pressure charts shown in Fig. 3 give evidence of the condition of the furnaces when working with the soft coke and with good, hard coke. The conditions on Feb. 7 and Mar. 21, as shown in Fig. 2, should also be compared.

It would be absurd to claim that hard coke alone is the remedy for all blast-furnace maladies for furnace operation fluctuated when the coke hardness did not. But there was no material change in coke hardness that did not show its effect upon the furnaces. The curves in Fig. 2 are comparable day for day, the coke data having been advanced by one day.

What has been said concerning the shatter test must not be construed as condemnatory of its general value. Fig. 4, showing the direct relation to furnace blowing factor of the shatter test and hardness number, respectively, demonstrates the coordination between furnace conditions and the quality of coke. That the furnace is more sensitive to change in the hardness of coke (tumbler test) than to change in the toughness of coke (shatter test) is shown by the daily comparison between hardness and furnac condition; see Fig. 2. For example, on Jan. 28, the shatter tests indicated the most brittle coke of the entire test period, 40 per cent. through 2-in. mesh, but the furnace operation was normal, as registered by a blowing factor of only 0.480. About Feb. 8, the shatter test again showed 40 per cent. through 2-in. mesh, but this time the furnaces were in poor condition; pressures were up to 25 lb. and the blowing factor reached 0.620. The best furnace week was that of Mar. 21, when the blowing factor was steady at 0.400 for seven days, but the shatter test showed both unwarranted variation and magnitude, being as high as 35 per cent. through 2-in. In each instance the hardness number was in accord with the furnace operation.

Hard coke means satisfactory furnace operation. Below a hardness number of 81, the furnace showed very seriously the effect of soft coke. Hardness over 85 does not show any particular effect, good or otherwise, upon furnace conditions. Beyond a doubt what must be sought in the furnacing quality of coke is its resistance not only to fragmentation but to abrasion. This characteristic is well indicated by the tumbler test. The use of steel balls in the tumbler is advantageous, as in the furnace the coke is in contact with masses of greater density than itself. The introduction of hot carbon-dioxide gas would add both interest and complexity to further investigations.

The numerical value of the blowing factor is affected by the initial size of the coke. If more than 45 per cent. passes through a 2-in. mesh, it requres little further reduction in size to tie up the furnace with a bad case of "small-coke indigestion." Hence if numerical comparison is sought between furnace behavior and the hardness of a coke that varies greatly in initial size, that item must be taken into consideration. During the test period, there was no marked variation in size.

Condition Affecting Hardness of Coke.

While the coal used is the most important factor in determining coke quality, it is difficult to establish a rule governing the quality of coke resulting from different coals, particularly those recognized as coking coals. We have verified the theory of David White that the hydrogen to oxygen ratio on a dry-coal basis affects the resulting coke quality, even substituting for quality the unpretentious term hardness, and though limited to but 20 points variation in the ratio (72 to 92 per cent.) as compared with his range of 10 to 290 per cent. Average values for successive 10-day periods show rather steady increase in both hydrogen-oxygen ratio for the coal used, and the hardness of the coke produced.

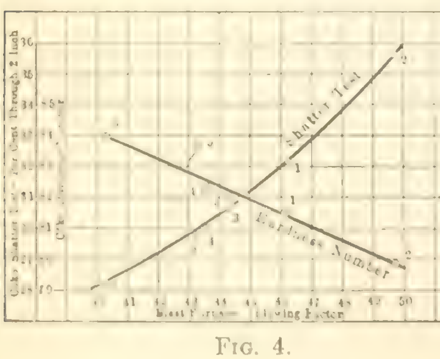


FIG. 4.

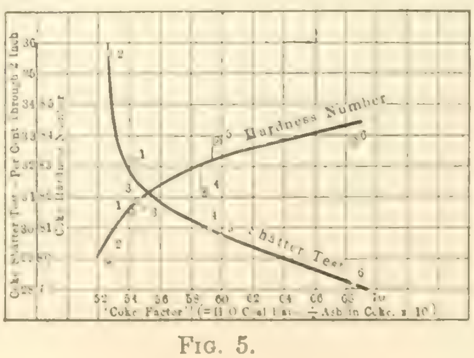


FIG. 5.

Fig. 4

Relation of Furnace condition to Coke Hardness shown by Shatter Test and Hardness Number.

Fig. 5

Effect of Coal Hydrogen-Oxygen ratio and Coke-Ash content on Coke Hardness shown by Shatter Test and Hardness Number

Period	Average Hardness Number of Coke	Shatter Test Per Cent Through 2 In.	Hydrogen-oxygen Ratio of Coal	Per Cent Ash in Coke
Jan. 25 to Feb. 13...	81.65	32.30	73.20	13.47
Feb. 4 to Feb. 13...	80.00	35.74	72.00	13.67
Feb. 14 to Feb.23...	82.00	30.00	74.90	13.70
Feb. 24 to Mar. 5...	82.39	30.10	81.00	13.64
Mar. 6 to Mar. 15...	83.77	29.92	81.60	13.62
Mar. 16 to Mar. 24...	83.91	28.30	91.20	13.27

Doctor Cochrane has shown the detrimental effect of ash in coke upon its hardness. The variation of ash in our coke, though small, was sufficient to corroborate Cochrane's claim, and ash content has been considered in this investigation as second among conditions that influence quality.

The third and final consideration is that of oven practice, as represented by the heat applied in coking. As heat is maintained in the empty ovens during slack times and as 75 per cent. of the coke was pushed on day shift, with an average coking time of 33 hr., some of the coke was short-period coke, and some long-period coke. The reported heats, in British thermal units per pound coal charged, are not deemed sufficiently accurate for purposes of direct comparison throughout the test period. We are satisfied, however, that overcoking has a detrimental effect on hardness, that while overcoking increases the depth of dense surface, it weakens the cell walls and structure, rendering the coke susceptible to attrition. The unprecedented drop in coke hardness from Feb. 5 to 10 is attributable largely to overcoking, there being an increase from about 1250 B.t.u. per pound coal during the previous 10 days, up to about 1500 B.t.u. during the period Feb. 5 to 10. The coal used during this period exhibits no great variation over that charged immediately previous or subsequent thereto. The hydrogen-oxygen ratio was low (72 per cent.) but nearly constant. During the final 10-day period of the tes, the number of British thermal units per pound coal again rose to about 1500, and served to counteract the effect of the high hydrogen-oxygen ratio, at this time about 90 per cent., in raising the coke hardness. No data are as yet available on the hardness of green coke, but it is reosanble to believe that such coke will be soft. In undercoking, strong cells walls have not yet been established; in overcoking, the cells have been enfeebled. Comparisons have been drawn between the hydrogen-oxygen ratio in coal and ash in coke, on one hand, and the hardness of coke on the other, averages being taken over successive 10-day periods. The hydrogen-oxygen ratio and ash have been incorporated into a factor:

$$\frac{\text{hydrogen-oxygen ratio}}{\text{per cent. ash in coke.}} \times 10 = \text{coke factor.}$$

which is plotted against both tumbler and shatter tests, in Fig. 5.

With fairly uniform coke ash, as the hydrogen-oxygen ratio drops below 74 per cent., the hardness of the resulting coke falls off rapidly; as the ratio exceeds 87 per cent., the effect on coke hardness becomes less and less marked.

That stocking coal affects the hydrogen-oxygen ratio is shown by the following: A 9-mo. stock of Davis coal showed a ratio of 102 per cent., while Davis coal direct from the mine showed a ratio of 125.8 per cent. Some 9-mo. stock of Fulton coal showed a ratio of 55.1 per cent. while Fulton coal direct from the mine showed a ratio of 57.5 per cent. It was the steady increase in the use of fresh coal that brought about the regular rise of the hydrogen-oxygen ratio throughout the test period.

Summary.

Coke hardness has an extremely marked effect upon blast-furnace health.

The furnace is more immediately sensitive to hardness, which resists wear and tear within the furnace, as shown by the tumbler test, than to toughness, which resists rough handling without the furnace, as shown by the shatter test. The tumbler test is therefore superior for daily control, its adoption is also recommended on grounds of simplicity, reduction of the personal equation, and the saving of labor.

The shatter test is of value as a matter of general record but does not surpass the tumbler test in this respect.

Both tests for coke hardness show reliable coordination with the hydrogen-oxygen ratio of the coal used; the higher this ratio, the harder the coke.

MANUFACTURING AND DEMONSTRATING PLANT FOR POWDERED-COAL EQUIPMENT.

Grindle Fuel Equipment Company hereafter will be the name of the Powdered-Coal Company, formerly known as Combustion Economy Corporation.

The capital stock has been increased to $1,000,000 in Illinois, and the company is having plans prepared for building a manufacturing and demonstrating plant, to consist of a Foundry, Machine and Sheet-Metal Shop, Office and Engineering Department, a complete powdered-coal preparation plant, and other departments necessary for the manufacture of powdered-coal equipment.

The complete plant will utilize powdered-coal for fuel, and conveying system and firing equipment of the company's manufacture will be installed.

In addition to the company's need for a plant of this kind to take care of the increasing amount of business which is being secured, it is believed that the demonstrating part of the plant will be of great benefit, both to the company for sales purposes and to prospective buyers of powdered coal equipment, in order that they may see exactly what the equipment will do before contracting for an installation.

The plant will be open to the engineers and officials of prospective customers in order that they may check results obtained with powdered coal.

It is expected that this plant will be located within the City of Chicago, and it is hoped that it will be ready for operation the latter part of this year.

The fire at the Trenton Shipbuilding Yard of the Nova Scotia Steel Company did not occasion extensive damage, and the loss is fully covered by insurance.

Personal.

Mr. Charles Bagley, who has for some months been acting as the technical assistant of the President of the Dominion Steel Corporation, with headquarters at Sydney, has resigned from this position, and is returning immediately to England.

The works of the Canadian Iron Foundry at Three Rivers, Que., have been temporarily closed. Resumption of operations is looked for about the 1st of April.

THERMIT WELDING IN STEEL WORKS

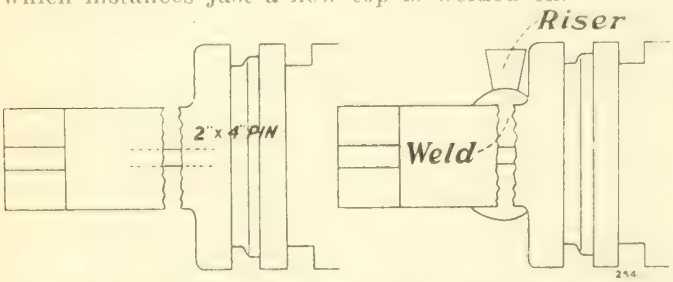
Welding Roll Necks.

The illustrations show a successful method used by Charles Fosburg, Sault Ste. Marie, Ont., for welding a great many rolls.

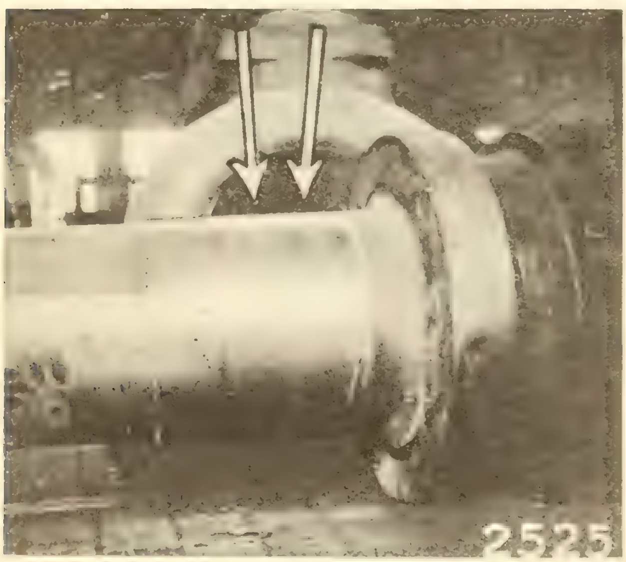
A patern is made for the neck and wabbler. This pattern is used for making a casting for this part. The casting is then lined up with the broken roll without machining and the two sections welded together as shown in the sketch. This makes an entirely new roll from a broken one and works finely whether the weld is large or small. The new end casting is not machined until after the weld is made, owing to the fact that certain strains are set up in cooling which are likely to distort and throw the billet out of alignment.

As the piece is cast in steel, Railroad Thermit, which is Thermit (a mixture of iron oxide and aluminum) plus a mixture of 1 per cent pure manganese, 5-8 per cent nickel-shot and 15 per cent mild-steel punchings, is used for all cast iron or steel rolls.

In certain cases only the wabblers are broken in which instances just a new top is welded on.



Method of welding a new neck to roll after a new end has been cast on



New neck welded to roll after casting the neck separately.

Simplifying the Casting of Long Steel Sections by Welding Together Smaller Units.

Ingot stripper plungers are extremely difficult to cast, owing to the fact that the cylinders, while 18 in. dia. and 25 ft. or more long, have walls only 1 in. thick. Inasmuch as it is almost impossible to obtain a perfect core and then anchor it so as to prevent floating, the thickness of the metal is often reduced on certain sides, thereby weakening it and resulting in frequent breakages.

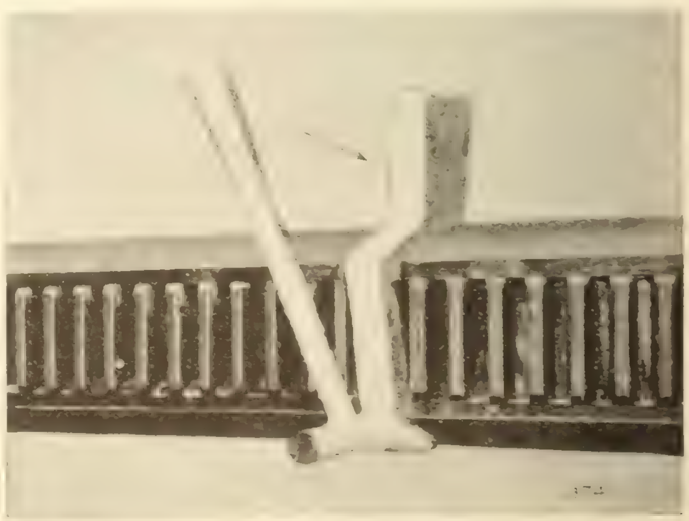
It has been found, however, that these castings can be made very much easier and of more uniform thickness by casting each cylinder in three separate parts of about 10 ft. in length each, instead of in one piece, and then welding the parts together by means of Thermit welding. All three welds can be machined off at the same time, and as the outside of the cylinder must be machined anyway, practically no more machining


Back view of thermit-welded ingot-stripper plunger after casting in small sections

is required than if the plunger were cast in one piece. Plungers have been successfully welded in this manner for the past ten years and the welds have stood up perfectly in service.

In the same way locomotive frames of unusual length and other long sections which are difficult to cast all in one piece can be cast in shorter lengths and these sections Thermit-welded together. By using this method smaller foundries can undertake this work. The number of parts to be welded will depend on the size of the foundry and available mold and pattern facilities.

Thermit welding may also be similarly used for building up shafts and other sections in inaccessible places, such, for example, as logging camps, where inadequate means of transportation makes it difficult to convey sections of unusual length. The Thermit process may be advantageously used in such places as mines, where limited space necessitates the assembling of a section from smaller units.


Front view of Ingot-stripper.

IRON ORE PRODUCTION IN THE UNITED STATES DURING 1920.

The iron ore mined in the United States in 1920, exclusive of that which contained more than 5.5 per cent of manganese, is estimated at 67,773,000 gross tons, an increase of 12 per cent as compared with the output in 1919. The shipments of ore from the mines in 1920 are estimated at 69,558,000 gross tons, valued at $290,607,-000, an increase in quantity of nearly 24 per cent and in value of nearly 43 per cent as compared with shipments in 1919. The average selling value of the ore per gross ton at the mines for the whole United States in 1920 was $4.18; in 1919 it was $3.61. The stocks of iron ore at the mines, mainly in Michigan and Minnesota, apparently decreased from 12,986,000 gross tons in 1919 to 11,145,000 tons in 1920, or 14 per cent.

The production of iron ore in 1920 was less than 2,000,000 tons below that of 1918 and is exceeded only by that of the war years 1916, 1917, and 1918. In 1920 shipments exceeded production by approximately 1,785,000 gross tons, but in 1919 production exceeded shipments by about 4,147,000 tons.

The record of the iron-mining industry in 1920 is the more remarkable when it is considered that shipments were hindered by a strike of ore handlers at the shipping docks early in the season, then by railroad tie-ups, due to a strike of switchmen, and by shortage of coal, cars, and vessels, and later by the closing down of blast furnaces, which was brought about by the cessation of the demand for pig iron and steel.

These estimates, which are based on preliminary figures furnished by producers of 97 per cent of the normal output of iron ore, were prepared by Ernest F. Burchard and Hubert W. Davis ,of the United States Geological Survey, Department of the Interior. The final figures will not be available until complete returns have been obtained by the Fourteenth Census. The results of the estimate are sufficiently complete to show the totals for the principal iron ore producing States, and by grouping together certain of these States the totals for the Lake Superior district and for groups of southeastern, northeastern, and western States can be obtained.

Lake Superior District.

About 86 per cent of the iron ore mined and shipped in 1920 came from the Lake Superior district, in which 58,173,000 gross tons was mined and 60,056,000 tons was shipped, increases of about 12 and 24 per cent., respectively, as compared with the quantity mined and shipped in 1919. The ore shipped in 1920 was valued at $257,543,000, an increase of about 43 per cent. These totals include the ore mined and shipped from the Mayville and Baraboo mines in Wisconsin, and ore shipped by rail as well as water from all mines, but exclude maganiferous ores that contained more than 5.5 per cent manganese. The ore is chiefly hematite. The stocks of iron ore in this district apparently decreased from about 11,887,000 gross tons in 1919 to about 10,-000,000 tons in 1920, or 16 per cent. The shipments of iron ore by water from the Lake Superior district in 1920 (including manganiferous iron ore), according to figures compiled by the Lake Superior Iron Ore Association, amounted to 58,527,226 gross tons, an increase of 24 per cent as compared with these shipments in 1919. A total of about 1,529,000 tons is thus indicated to have been shipped by rail. The average selling value of the ore at the mines in the Lake Superior district in 1920 was $4.29 a ton; in 1919 it was $3.70.

The mines in Minnesota furnished 67 per cent of the total iron ore shipped from the Lake Superior district in 1920 and 58 per cent of the total of the United States. The mines in Michigan furnished 31 per cent of the lake shipments and 27 per cent of the grand total.

Southeastern States.

The Southeastern States, which constitute the second largest iron-ore producing area, including the Birmingham and Chattanooga districts, mined 6,663,-000 gross tons of iron ore in 1920, an increase of 16 per cent as compared with 1919. The shipments of ore from these States to blast furnaces in 1920 amounted to 6,575,000 gross tons, valued at $20,994,-000, an increase in quantity of 18 per cent and in value of nearly 32 per cent as compared with the quantity and value of shipments in the previous year. The ore contains about 78 per cent of hematite, 21 per cent of brown ore, and 1 per cent of magnetite. The average selling value of the ore in these States in 1920 was $3.19 a ton; in 1919 it was $2.87. The production of ore in these States in 1920 apparently slightly exceeded the shipments, so that the moderate stocks at mines and murnace yards were increased.

Northeastern States.

The Northeastern States, which include New Jersey, New York, and Pennsylvania, in 1920 mined 2,027,-000 gross tons of iron ore and shipped 2,070,000 gross tons, an increase of 12 per cent over the quantity mined and of 36 per cent over the quantity shipped in 1919. A slight decrease in ore stocks is thus indicated. The average selling value of the ore in these stocks at mines and furnace yards were increased. Most of this ore is magnetite.

Western States.

Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Washington, and Wyoming, the iron-ore producing States in the West, are estimated to have mined and shipped 734,000 gross tons of iron ore in 1920, an increase of 8 per cent as compared with the quantity mined and shipped in 1919. No large stocks of iron ore are maintaiend at western mines. The average selling value of the ore in this group of States in 1920 was $1.83 a ton; in 1919 it No large stocks of iron are maintained at western States, but considerable brown ore and magnetite are mined.

Other States.

Other States, including Connecticut, Maryland, Massachusetts, Missouri, and Texas, in which there are small iron mines that produce chiefly hematite and brown ore, mined about 176,000 gross tons in 1920, an increase of 63 per cent as compared with the quantity mined in 1919. The shipments from mines in these States in 1920 are estimated at 123,000 gross tons, an increase of 16 per cent over shipments in 1919. The estimated average selling value of the ore from these States in 1920 was $4.18 a ton; in 1919 it was $3.99.

Imports and Exports

The imports of iron ore for the eleven months ending November 30, 1920, amounted to 1,145,139 gross tons, valued at $4,438,958, or $3.88 a ton. The imports for the year 1919 were 476,461 gross tons, valued at $2,385,689, or $5.01 a ton. The exports of

iron ore for the eleven months ending November 30, 1920, amounted to 1,130,921 tons, valued at $6,119,510, or $5.41 a ton, as compared with exports for the entire year 1919 of 996,569 tons, valued at $4,308,746, or $4.32 a ton. The statistics of imports and exports were compiled from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

Pig Iron.

The total pig iron and blast furnace ferroalloys, principally ferromanganese, spiegeleisen, and ferrosilicon, produced in the United States in 1920 amounted to about 36,721,000 gross tons. Of this output approximately 36,411,000 tons consisted of anthracite and coke pig iron and ferro-alloys and 311,000 tons consisted of charcoal iron. In 1919 the corresponding quantities were 31,015,364 tons of coke and anthracite pig iron, including ferro-alloys, and 327,097 tons of charcoal iron, as reported by the American Iron and Steel Institute. The net increase in the total quantity of pig iron produced in 1920 over that produced in 1919 was 18 per cent.

The month of highest production in 1920 was March, when the quantity reached nearly 3,376,000 tons, and the month of lowest production was December, when it was about 2,700,000 tons. The next low and high months were April and October, when the output was about 2,750,000 tons and 3,290,000 tons, respectively. The curve of market prices of pig iron during the year showed a steady rise from January to August or September and then a decline to the end of December. Basic pig iron, which averaged $37.40 a ton at Valley furnaces in January, averaged $48.50 in September and $33 in December. No 2 foundry at Philadelphia averaged $44.10 in January, $53.51 in September, and $34.79 a ton in December, 1920, according to the Iron Age.

The following table shows the iron ore mined and shipped and the value of the shipments in the United States by the principal producing States. The figures for 1919 and 1920 are subject to revision.

Estimate of iron ore mined and shipped in the United States in 1919 and 1920.

District.	Ore mined (gross tons).		Ore shipped.			
			1919		1920	
	1919	1920	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
LAKE SUPERIOR.						
Michigan	15,471,000	17,232,000	13,088,000	$47,837,000	18,715,000	$83,628,000
Minnesota	35,767,000	39,964,000	34,593,000	128,789,000	40,274,000	169,654,000
Wisconsin	888,000	977,000	782,000	2,859,000	1,067,000	4,261,000
	52,126,000	58,173,000	48,463,000	179,485,000	60,056,000	257,543,000
SOUTHEASTERN STATES.						
Alabama	5,034,000	5,850,000	4,837,000	13,203,000	5,769,000	17,903,000
Georgia	80,000	89,000	85,000	389,000	94,000	474,000
North Carolina	67,000	69,000	67,000	240,000	69,000	256,000
Tennessee	271,000	347,000	271,000	932,000	347,000	1,243,000
Virginia	288,000	308,000	290,000	1,150,000	296,000	1,118,000
	5,740,000	6,663,000	5,550,000	15,914,000	6,575,000	20,994,000
NORTHEASTERN STATES.						
New Jersey	409,000	420,000	331,000	1,593,000	417,000	2,592,000
New York	858,000	927,000	648,000	3,694,000	978,000	6,482,000
Pennsylvania	547,000	680,000	543,000	892,000	675,000	1,138,000
	1,814,000	2,027,000	1,522,000	6,179,000	2,070,000	10,212,000
WESTERN STATES.						
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Washington, and Wyoming	678,000	734,000	678,000	1,273,000	734,000	1,344,000
OTHER STATES.						
Connecticut, Maryland, Massachusetts, Missouri, and Texas	108,000	176,000	106,000	423,000	123,000	514,000
Grand total	60,466,000	67,773,000	56,319,000	203,274,000	69,558,000	290,607,000

EDITORIAL

Unemployment Compensation

A contributor from New Glasgow, in an article in this issue, raises questions regarding unemployment insurance, or unemployment "compensation" (which is not by any means the same thing) that are much more easy to propound than to answer. It has not yet been proven in the world's history that employment, or a means of livelihood, is a thing that can be guaranteed by any system of man's devising. The saying is current that the world owes every man a living, yet the identity of the paymaster, or his financial responsibility has never been determined. Unemployment insurance has been attempted on quite a large scale in Europe, but the best laid schemes of social economists went agley through the lunacy of kings. Half the world has almost slipped back into the Dark Ages, and what is chiefly worrying millions of educated Europeans today is not state-directed unemployment insurance; but the elementary passions of men, hunger, greed, lust and murder, and we are far, very far, from a condition of continuity in employment, or a condition of continuity in anything, unless it be trouble.

The suggestion that employers should bear some share of responsibility for creating a centre of employment, without fair guarantees for its continuity, will bear thinking over. The censorship of incorporations to the extent of requiring disclosure of a fair prospect of permanence of employment, is not a duty that governments have as yet considered came within the scope of statute law. The protection of investors from fraudulent representations is as far as governments have cared to go, and they have not gone very far even in this connection. A certain amount of prudence must be presumed in all those who engage in business ventures, and the inexorable, but on the whole salutary law of the survival of the fittest, cannot be too far over-ridden by government enactments, as the aftermath of the war has abundantly proven.

Employment insurance presumes some sharing of financial responsibility by those employed, but trade unions have, so far, fought most bitterly against anything that seemed to merge the interests of the employed with those of the employer. Profit-sharing, industrial councils, and investment in stocks and bonds, have been energetically opposed by certain sections of labor thought, that hold the interests of labor and capital to be incapable of reconcilement, let alone of merging.

As our contributor truthfully states, "unemployment relief, unless very carefully administered, is apt to cause still more idleness". Labour has hitherto striven to bring down the capacity of the individual to that of the lowest productive type, and has discouraged, by secret or by open means, all attempts to reach the standard of the higher type of productivity. It has also attempted to prevent the operation of economic laws by denying their existence, and at the time of writing, British miners are engaged to asserting their right to get more for the product of a given coal-mine in wages than that product will fetch in the open market. The British miner has brought about a nationwide strike by denying the necessity for profit in a business enterprise, and it is because of the fundamental wrongness of such an attitude that the strike will fail.

There are two attitudes, commonly exhibited by each of the two indefinitely distinguished divisions of citizenship known as Capital and Labor, that seem wrongly taken. Capital assumes its right to access to a "labour market", without responsibility to guarantee continuous employment. Labour presumes the possibility of a state of continuous employment, irrespective of financial factors and markets. Both these assumptions are in error, but there would seem to be ground for common agreement if workmen would concede that they should share with employers in financial responsibility, and would cease attempting to fix the rate of production by the ability, or the inclination, of the least expert members of a given craft.

We do not see how the government in Canada could administer a scheme of unemployment insurance. The government is already one of the largest single employers of labour in Canada, and for this reason, it lacks the detached and disinterested viewpoint necessary to equitable administration of labour laws. Government control of industry is dangerous, because, when this is the case, a labour dispute becomes not merely a strike, but a political revolt. If the governments of the countries that were at war would relinquish their control of industrial operations they could

assume function as mediators between the forces of Labour and Capital. As employers they cannot acceptably do this,

In the direction of large, industrial operations, requiring heavy purchases of materials, the Canadian Government is also finding itself, under press of financial deficits, forced to hold out for prices of materials that require wage reductions, and the Government is torn between the piling up of further deficits or the creation of unemployment in order to reduce material prices to a purchasable level. In such a position a government certainly could not administer unemployment "compensation". The Government desires, at this moment, without doubt, to rehabilitate its railways by purchase of rolling stock and track materials. It also requires large tonnages of coal, and, must recognize that the present is a favorable moment for giving orders, seeing that coal-mines all over North America are shut down, and steel manufacture is at the lowest ebb since the panic of 1907. Nevertheless orders are being withheld, and doubtless with much justification from the standpoint of all the people, because everybody realizes that miners' and railwaymen's wages are holding up the cost of living and the price of steel, and that some reduction in the remuneration of these men must be enforced in the general public good. Unemployment insurance, in the face of such a tangle, would break any government that attempted it.

Nevertheless, our contributor has propounded a problem that engineers might tackle as a relief to engineering status legislation, because it is primarily the problem of the engineer, and it is most distinctly not a problem that can be dealt with in Ottawa.

RELATION OF ELECTRICAL MANUFACTURING TO IRON AND STEEL IN CANADA.

The steady growth of the Canadian General Electric Company reflected in the financial statement of this enterprise for 1920, and emphasized by Senator Nicholl's review of the Company's growth from a ten-thousand dollar syndicate to a corporation having assets exceeding thirty-one million dollars within thirty-three years, is a matter of some importance to the metal-working industries in Canada as indicating a trend in our industrial development. Recently it has been announced that the English Electric Company, an important consolidation of British electrical companies, intends to erect a plant in the vicinity of Toronto, and certain developments in the Montreal district indicate that responsible and far-sighted leaders of industry are appreciating the correctness of Senator Nicholl's forecast of the probable growth of hydro-electric systems in Canada, made not only in his recent report to the General Electric shareholders, but emphasized even more strongly in the report for 1919.

The equipment and capital outlay required for the casting and machining of water-wheel parts is large, and would not be justified in many countries. In Canada, however, the vision of those who see the likelihood of many large and repeated orders for hydro-electric machinery is entirely justified by national resources and national needs. In that portion of Canada where waterpowers are most abundant and most dependable there exists no other natural source of light, heat and power available for industrial uses, and all fuels, except wood and peat, must be brought from points distant 750 to 1,000 miles. Apart altogether from the conveniences and economies of electrical power, which has virtually superseded all other methods of transmitting and applying energy to industrial operations, the suitability of electrical power to conditions in Central Canada is bound up with the absence of all other local sources of power. It is therefore in the nature of things to anticipate in Canada the development of a specialized technique in developing waterpowers for generation of electricity, and in applying electricity to industrial uses, that will have unusual excellences and the very widest variety and extent of uses.

For some reason difficult for an observer to assess — but probably associated with politics — there has in recent years been a tendency to deprecate the increase of hydro-electric power development in Ontario and to minimize its suitability for industrial uses for transportation. Some writers have gone so far as to forecast the obsolescence of electrically-propelled vehicles and their supercession by explosion-motor propelled vehicles, using gasolene or other motor-fuel. Without debating the comparative merits of electric and gasolene motors, the fallacy of such arguments, so far as Central Canada is concerned, lies in the fact that hydro-electric power is available at home, whereas motor-fuels and all other fuels must be imported, and must stand, added to their first cost, the cost of long-distance transportation.

To what extent electric energy can be used to reduce iron ores and to make steel in Canada has not yet been demonstrated, but not only does progress in electrical-furnace practice suggest that economic use of electricity in metallurgical processes is likely to become more general; but the cost of lake iron-ores, the cost of coking-coal, and the cost of assemblage of the raw materials of steel manufacture in central Canada, will steadily increase from now on. The annual decrease in metallic content of lake ores, combined with the other conditions referred to, is year by year increasing the relative value of Canadian iron-ores, despised as they may be at this date. Should electric power, by intensive development of our waterpowers, be rendered more plentiful and available at moderate rates, and should Canadian metallurgists make progress in applying electrical energy to reduction of native ores; both of which conditions seem

likely to be fulfilled, it will become increasingly evident that the iron and steel industries are vitally interested in electrical enterprises in Canada, as these bid fair to afford them an outlet for iron and steel products, and, eventually, will function as powerful aids in the commercial adaptation of electricity to metallurgical industries, both primary and secondary.

The necessity for development of waterpowers for generation of electricity is not nearly so pressing in the United States as it is in Canada, because of the unique coal wealth of the United States compared with Canadian poverty in this respect in the Central provinces, but the extent and financial importance of such enterprises as the General Electric Company of Shenectady and elsewhere is a fair condition of the coming importance of electrical manufacturing companies in Canada.

FIRES AT FOUNDRIES AND MACHINE SHOPS.

There have been in recent months a succession of fires, particularly in the Maritime Provinces, at foundries and machine shops. In one or two instances these fires have had disastrous effects on the immediate locality, as for various reasons, re-building has not been undertaken, and local industries have ceased. Most of the fires have originated in wooden buildings. Wood seems a singularly unsuitable material in which to house cupolas and other heating contrivances, or in which to place tools and machinery that exceed in value by many times the structure which houses them. Particularly is the practice of keeping valuable patterns in wooden buildings likely, sooner or later, to result in total loss by fire. The eventual destruction of most wooden buildings by fire is usually only a matter of time, and now that wooden construction is not so excusable on the ground of comparative cheapness as it formerly was, it would seem to be time to entirely abandon wooden construction in all metal-working industries. Few countries are so naturally provided with materials suitable for non-inflammable construction as is Canada. We have gypsum, building stone in every variety, asbestos, good building clays, and there are many Canadian concerns prepared to quote on all kinds of structural steel-framing, fire-proof tiling and blocks. Then there is the by no means inconsiderable saving in insurance premiums possible through fireproof, or reasonably fireproof building, and the further likelihood that insurance companies will before long refuse insurance risks on obviously unsuitable wooden structures, housing machinery and finished material that represents high values.

Consequential damages, or the loss of business caused by the stoppage of operations by fires, cannot be insured against, except in the very partial form of "use and occupancy" insurance, and, sometimes, as previously mentioned, fire kills the industry entirely.

Many new foundries are under construction at this time, and have quite recently been built in Canada, in which the construction is of the most approved fireproof type, and, of course, there can be no doubt that the safety, convenience and permanence which these new structures will possess will many times repay an extra cost entailed in their construction.

BRITISH EMPIRE STEEL CORPORATION, LTD.

A term that has become fashionable in the United States is used to describe manufacturing enterprises that control raw materials and assemblage facilities as a basis for the production of finished goods, and also control transportation equipment necessary to distribution to the consumer. These self-contained enterprises are known as "integrated concerns. This arrangement makes, of courses, for economy and minimum production costs, and also favours stabilization of earnings and permanency of investment yield. It would seem to be in every way admirable and logical, which renders recent decisions of the United Supreme Court attacking their validity, as opposed to the public weal, extremely puzzling.

Should the long-deferred consolidation of the Dominion Steel Corporation and the Nova Scotia Steel & Coal Company now take place, there will be seen in Canada as perfect an example of an integrated enterprise as is conceivable, and we believe the consolidation will not be opposed to public welfare, but will be distinctly in the public advantage, if industrial permanence and maximum economy in production are to be conceived as things to be desired in the general good.

Under the stress of war conditions, many quasi-public utilities, such as coal mines, railways and agriculture, were taken under the administration of governments in order to achieve maximum production at minimum cost to the consuming public, and there can be no doubt but that the root idea which impelled governments to such action was correct. That idea was unified control. The result has been disastrous, largely because the control was prolonged beyond the necessity, but primarily because control of business involving wages and hours of labour and the discipline of supply and demand, is a duty of which a government, electorally selected by popular ballot, is inherently incapable. An electoral government is not a free agent in such matters. Only autocracy, in the form of an absolute dictator, can usefully, or efficiently, perform such functions. The Canadian Government Railways are the best-known example of the futility of popular control, except in cases where the idea has been followed to its logical conclusion, which is the abolition of private property-ownership. Such examples as exist of pushing the communal idea to absurd lengths are not encouraging to its wider extension.

The experience of the past few years would indicate the desirability of the completest possible integration of manufacturing enterprises, directed by private enterprise, and subject to such control by governments as is properly exercised through charters and constitutional procedure.

It follows that business combinations should not be composed of incongruous or unrelated activities, because, in such instances, the beneficient idea of unified control is usurped by a vicious desire for control without unity, a desire that has no justification from the standpoint of the public weal.

The justification for the formation of the British Empire Steel Corporation is that it will place under unified control a network of congruous and interrelated operations. Observance of the unities is as much in place in business as it is in literature and the arts.

THE BRITISH COAL STRIKE.

When the British coal miners went back to work in November last, no settlement had been arrived at except an understanding that a basis of co-operation would be worked out by the 31st of March with particular regard to the principle upon which surplus profits were to be dealt with.

The issue at that time, and the issue at this time, is not one between the men and the colliery proprietors, but it is a constitutional question, and turns, in its essence, upon the extent to which private ownership is permissible.

The miners and the employers progressed in their negotiations a surprisingly long way. They had agreed that any surplus profit remaining after a minimum owners' profit (accompanied by a standard wage) should be divided between the miners and the companies. This is a step much in advance of anything ever seriously suggested in the coal industry on this side the Atlantic. It is very distinctly a limitation of private ownership, and admits a principle not hitherto conceded by employers in Britain. It would seem the employers had gone a very long way to seek conciliation.

The rock on which negotiations have split is that of national settlement of the wage question. Mr. Evans Williams, the president of the Mining Association of Great Britain, calls the difference between the miners and the employers one of fundamental economic principle. The men demand that "the whole industry shall be treated as one financial unit—just as if it belonged to one owner—all the profits and losses of the individual owner being pooled, and each receiving out of the pool a certain amount sufficient, presumably, to enable him to keep his colliery working without loss."

The coal owners are unalterably opposed to this principle, nor is it difficult to see why this should be the case. The miners desire to eliminate all the natural competitive features of the several British coalfields, and wish that an unremunerative colliery, say in the Forest of Dean, shall be maintained in operation out of the profits on the operation of a new colliery, say in the Yorkshire Coalfield. Mr. Evans Williams maintains that such a principle "would be suicidal to the industry." The reply of the Miners Federation to Mr. Williams's statement concurred in his explanation of the fundamental difference of opinion between the two contending parties. The miners insist on a national settlement. The owners state they "exclude the question of unification and a national settlement."

This is the issue, and it is a very grave one. The matters of de-control and subsidies are merely incidental to the main issue, which is the desirability and the feasibility of prosecuting a national "key" industry without regard to the cost of production or the necessity to conform to outside competition, fluctuations of demand and other expressions of the law of supply and demand hitherto regarded as immutable.

It is, of course, well-known that the miners' leaders hope to offset the question of foreign competition by achieving a world-wide federation of coal miners (and not coal miners only) and the explanation of much of their policy is to be sought for in the deliberations of the Miners Congress at Geneva. In this regard the attitude of the delegates from Canada and the United States towards the question of national control of raw materials at the conferences of the League of Nations is significant; as it reveals a distinct divergence of interest between European and American coal-miners, arising from the superior competitive ability possessed by the coal industry on this side, based on coal resources that completely overshadow those of the rest of the world. Britain is threatened in her commercial supremacy by the superior natural resources of the American continent, now entering upon a stage of development that Europe cannot hope to rival. The British coal miner, hitherto, has been the mainstay of his country's commercial greatness. It is to be hoped he will not prove the main instrument in Britain's commercial declension, but it appears not unlikely to happen in that wise, because of a viewpoint that is not so much insular as European, and is chiefly mistaken in conceiving that the world revolves around Europe, when actually the balance of industrial power has shifted to the western hemisphere. — "Canadian Mining Journal".

A USE FOR OLD LAMP BULBS.

Carbon tetrachloride bombs have found favour in many American power plants for fire extinguishing, and their use has resulted in the prompt quenching of fires that might have resulted in serious consequences had quick action not been taken.

Burned-out incandescent lamp bulbs of a suitable size are converted into bombs by removing the metal base and filling the glass bulb with the liquid. By breaking the tip from the bulb while it is immersed in a bucket of the carbon tetrachloride the filling can be easily accomplished. A drop of wax is placed over the small hole at the tip to seal the bulb.

Unemployment Compensation

JOHN S. WATTS, New Glasgow.

If we, as we do, grant the right to any person to start up a factory, without any enquiry as to the prospects of continuous employment in said factory, upon whom rests the responsibility if the factory eventually is closed, either partially, permanently, or temporarily, and men are thrown out of work, with all the poverty and deprivation that usually follows, not only to the men directly affected, but also to the community in which the factory is located?

What may be termed the immediate responsibility for the calamity of a factory closing, can generally be determined as resting upon either the management, the employees, or upon outside conditions over which neither party have any control, or could reasonably have been expected to foresee, or partially upon each. That is, the failure may be due to inefficient management, either in the conduct of the business, or because the demand for the product of the factory was already well supplied, before this factory was built. It may fail from the excessive demands of the employees, or their lack of energy in their work. In either of these cases the immediate responsibility is not difficult to place. In the case of failure from some cause or causes, for which neither employer or employee, can be held responsible, the responsibility must rest with the people as a whole, who might have, because of their wider powers, in the control of affairs, and ability to gather data, from which to forecast probable events, have averted, or at least alleviated, the consequences of the failure.

By the immediate responsibility, I mean the responsibility resting upon the person or persons, whose actions have brought about the failure. There is another responsibility, namely that of releasing those who are in no way immediately responsible for the failure, from its consequences. In common justice, it will not be denied that those immediately responsible for unemployment, should be held responsible for its consequences upon those innocent of any action in bringing it about.

That those whose actions caused the failure do themselves suffer loss by it, does not, in equity, relieve them from responsibility for the losses of those who suffer from it, though without blame.

When unemployment is due to causes which cannot be controlled, by either the employer or employee, the responsibility for paying the losses incurred must perforce be borne by the people as a whole, and the cost of doing this, at least, in part if not in whole, cannot be avoided; except the people discover some way of overcoming these causes, or some manner of utilizing the labor thrown out of its regular employment temporarily, until the conditions return to normal.

A good example of such a case is that of the bricklayers, who being unable to work in inclement weather, are paid while working a higher rate than is paid for work of a similar skill, not subject to this trouble, to compensate them for the time unavoidably lost during bad weather. In this case the public as a body have to bear the loss incurred through storms, by paying more for their buildings than they would have to if bricklaying could be carried on continuously. The only way to escape this loss is for the people to devise some method by which the bricklayers could work uninterruptedly, in any kind of weather, or else to arrange some scheme, by which the skill of the bricklayers sould be used in some other direction during stormy weather. But in any case the responsibility is directly on the public, to compensate the workers for their loss.

The case of a plant the demand for whose product has fallen off, and in consequence thereof, the management are compelled to discharge part or all of their employees, is not so simple.

The reduced demand may be due to inefficient management, in having erected a plant larger than the demand called for, or to the employees having demanded higher rates than the value of their work would warrant or to some new invention, superseding the article being manufactured. Or, it may be due to a combination of any or all of these causes.

However, investigation of each case should be able to bring out the proper party or parties upon whom to place the responsibility, and upon them should be laid the burden of paying compensation to the innocent losers. Where the employment is caused by what the Shipping Laws call "The Acts of God," that is causes beyond human control, it is only fair to spread the burden over the whole population.

It is to the point now, to examine the methods and proposals so far brought out, to place the responsibility for caring for the unemployed. For some few years, in some of the European countries, a system of governmental paying of the unemployed, has been used. In general, the cost of this, is paid for partly by the workers themselves, in the form of small weekly payments deducted from their earnings, while at work. And partly by the employers who pay into the fund, a percentage of their payroll, the balance required being furnished by the Government out of the general treasury. This method is also being proposed to be used on this Continent.

The result, of this idea of paying the unemployed, is theoretically to place the cost, approximately equally upon all the parties concerned namely the workers, through their weekly payments, on the employers, through the tax on their payroll, and the balance on the people through their government. In actual practice the workers, may, if members of a strong trades union, force for a time at least, the other two parties to carry the workers' share of the cost, by demanding a higher wage, sufficient to reimburse them the amount of their contribution to the fund. The employers on their part, are more likely to add the tax to their cost of doing business, and hand it on to their customers in the shape of additional price, and so finally we find that it is quite probable, that the public in the end pay for the whole cost.

In any case the burden will fall on the shoulders of those who cannot avoid it, without any regard as to who are the parties that are immediately responsible for the need of incurring this cost at all.

Practically all of the trade unions have an unemployment fund, furnished by the contributions of its members, and used to pay small weekly payments to its members during temporary unemployment. The cost in this case is supposed to be carried by the workers themselves, but is probably in fact, passed on ultimately to the public as part of the cost of the goods purchased.

If, as has been suggested, an unemployment fund be subscribed to by both the employees and employer,

the final result would be the same, namely payment by the public, no matter whose was the fault.

To the money thus paid out to the unemployed must be added, what is probably a greater loss still, namely, the material wealth which the unemployed could have produced if continuously employed, and the loss in efficiency of the workers, which follows a period of idleness. This additional loss is without doubt, borne wholly by the general public.

None of the above measures, do any more than alleviate the distress caused by unemployment, and will never bring about a decrease of idleness. In fact, it is obvious, that unless very carefully administered, the payment of unemployment relief is apt to cause still more idleness. If the payments made to the unemployed, are, as they should be, high enough to relieve all distress, they will be high enough to cause a noticeable percentage to be content to remain idle, and for this reason any such fund must be handled by a body clothed with too much authority to be easily overawed by any other body of men.

The lines along which we must work, to provide the required relief, in such a way as to tend to reduce unemployment to a minimum, are those outlined in the beginning of this article, namely that the cost of this relief must fall upon those who caused the unemployment.

This could be arranged by having the relief fund administered by the government, who would when the unemployment was determined to have been unavoidable, pay the whole cost. This would impress upon the government, the necessity of using all possible measures to remove the causes, and at the same time, if the government used the staff who administer the fund, to keep in touch with the demands for labor over the whole country, it would be able to put the men back to work more quickly than would be possible otherwise.

If it was proved that the unemployment was caused by some failure on the part of the employer, he could be made to bear the cost in some such way as the following. Let every manufacturer be compelled to subscribe to the unemployment fund, until the amount so subscribed by him amounted to sufficient to pay all his employees out-of-work relief, for a certain period of time, say three months. This period should be that found necessary to replace the workers in other employment, or to cover the time of temporary unemployment in that factory. Whenever an employer had sufficient funds deposited with the government to cover this liability, his payments would cease, and the current rate of interest would be paid him on the amount, after deducting the cost of administration. Whenever by reason of unemployment in his factory, the fund was drawn upon, the employer would recommence his payments, until the maximum amount was again replaced.

The effect of this scheme, would be to help the efficient manufacturer who furnished continuous employment, in competition with those less efficient ones, who would be under the necessity of paying more continuously into the fund, and so tend to reduce unemployment. It would also discourage the erection of unnecessary new factories, having little prospects of continuous existence, because when a plant came to be permanently closed, the whole amount paid into the fund by that company, would probably be forfeited. The whole tendency obviously, would be to encourage the company giving continuous employment, and so reduce the evil of unemployment.

When the employees themselves were proved to be the party at fault in causing unemployment the payment of relief becomes a matter of generosity or expedience on the part of the people at large, and should be, if anything at all, only sufficient to support life, and in essence is no other than the giving of charity.

BOOK NOTICES.

PATTERNMAKING: By Ben Shaw and James Edgar. 4 by 6½ inches 106 pp. with index. Stiff cardboard backs. Price one dollar. Sir Isaac Pitman & Sons, Ltd., 70 Bond Street, Toronto.

This is a recent addition to Pitman's Technical Primer series. The treatment of the various branches of technical industry covered by this series of primers is designed to present a sound survey of fundamental facts, principles, equipment and practice. In the treatise on patternmaking above noted the authors have written primarily for the benefit of students, apprentices and young journeymen, and the patterns of which ilustrations are given have been selected to demonstrate well-defined principles. The treatise contains nothing that is superfluous, and as it is evidently written by men with much practical experience, and is obtainable at a moderate price, it can be well recommended. The volume, which is uniform with the rest of this interesting series, is convenient pocket-size, and is printed on good-quality paper from very clear type.

THE FUNDAMENTAL PRINCIPLES OF WATER POWER ENGINEERING: By Frank F. Ferguson. Sir Isaac Pitman & Sons.

This is also one of the primer series above noted, and deals with a subject that is of much interest in Canada at this time. The treatise deals with the theory, selection, design and operation of water turbines, and is written as an introduction to more advanced text-books, of which a list is appended to the primer, together with a list of periodicals and societies that are mainly interested in water power engineering. The illustrations are numerous, and chapter headings will give an idea of the scope and arrangement of the book. The chapters deal with types of turbines and their application, the turbine runner (Francis type) and the theory of its design; specific speed, conditions in the turbine runner, formulae and constants; Pelton wheels, water velocities in hydro-electric plants; the pipe-line, and regulation of speed and pressure rise. The author does not claim any originality in the matter presented, but believes that it gives a more concise and ordered presentation of data than has hitherto been available for the benefits of students. The metric system is used throughout the treatise.

FIRE AT RECORD FOUNDRY, MONCTON

The warehouse and machine shop of the Record Foundry & Machine Company at Moncton, N.B., was destroyed by fire on the 28th March. The damage, which is covered by insurance amounts to about \$70,000. Seventy-five employees are temporarily put out of employment, but it is understood that immediate reconstruction will be undertaken.

Annual Meeting of the Mining Society of Nova Scotia

The Annual Meeting of the Mining Society of Nova Scotia was held in Halifax on April 5th and 6th. About fifty members were in attendance at the meetings, and seventy-five persons attended the Annual Dinner. The Secretary reported the funds of the Society as standing at $1,229.

A letter ballot on a proposal to change the name of the Society to the Mining & Metallurgical Society of Nova Scotia was found to result in a majority against a change.

The proceedings and papers dealt chiefly with coal mining, but papers dealing directly or indirectly with the iron and steel industries were read as follows:

GEO. D. MACDOUGALL,
President, Mining Society of Nova Scotia.

Mr. Hugh B. Gillis, Superintendent of Mines & Quarries for the Dominion Iron & Steel Company read a paper on the use of mechanical loaders at the iron-ore mines at Wabana, which is published elsewhere in this issue.

Mr. Carl H. Marsh, Chief Engineer of the Dominion Steel Corporation, read a paper on Central Station Power, with particular regard to colliery requirements. Mr. Marsh's paper was followed by a discussion which emphasised the necessity for standardization of frequencies, and condemned the use of odd frequencies. Mr. C. H. Wright, of the General Electric Company, said that 60 cycles was becoming a standardized frequency in the United States. The likelihood of great extension of electric power in mining operations in Nova Scotia and Newfoundland was referred to. In Nova Scotia seventy per cent of the coal now being mined is from submarine workings, and all the ore at Wabana is being taken from under the sea. Electricity is the only motive power known that possesses the flexibility and the possibility of economic transmission required for long-distance transmission underground, and its extended use will be an outcome of necessity.

A paper was presented by Mr. A. W. MacDonald, Superintendent of Industrial Relations of the Dominion Steel Corporation detailing the welfare activities of this company. This paper had previously been read at the Montreal Meeting of the Canadian Institute of Mining & Metallurgy.

GEO. C. MACKENZIE,
Secretary, Canadian Institute of Mining and Metallurgy.

Prof. H. Sexton, Director of Technical Education in Nova Scotia, spoke regarding the possibility of saving the productive power of industrial cripples by vocational training, and suggested that the experience, and to some extent the staffs, of the Soldiers' Civil Re-establishment Department might be turned to advantage in rehabilitating the cripples of industry. He suggested that the Workmen's Compensation Boards should be permitted to expend certain of their funds in re-training injured and disabled men, a proceeding that in many instances could be relied upon to relieve the compensation funds of future payments.

Visit to Halifax Shipyards.

On the afternoon of the 5th April, the members of the Society were taken over the Halifax Shipyards,

and were afterwards entertained by Mr. J. E. McLurg, in the General Offices.

There are two 10,500 ton ships on the stocks, the Canadian "Cruiser" and "Constructor", which are being built for the Dominion Government. The "Cruiser" will, it is expected, be launched in June next, and the "Constructor" about September. The Company has no further building orders in immediate prospect.

Evidence of close connection with the Dominion Steel Corporation was visible in the presence of two locomotives of the Corporation which are being rebuilt at Halifax. A number of the Corporation's freighters are also repairing at the shipyards, some eight vessels having received repairs of varying extent during the recent months in preparation for the navigation season. About 1,230 men are at the present time employed at this Shipyard. A number of plates from the Sydney plate-mill were being used at the time of the Mining Society's visit.

The officers of the Mining Society include Mr. George D. MacDougall, General Superintendent of the Nova Scotia Steel & Coal Company, who was elected president of the Society. Mr. MacDougall is succeeded as President of the Accident Prevention Society of Nova Scotia by Mr. J. E. McLurg, the General Manager of the Halifax Shipyards, and precautions for the safety of the workmen were everywhere visible in the yard.

The meeting was attended by Mr. G. C. Mackenzie, the recently appointed Secretary of the Canadian Institute of Mining & Metallurgy. The Mining Society of Nova Scotia had not met in Halifax since 1913, the year before that in which the headquarters of the Society were transferred to Sydney.

CANADIAN GENERAL ELECTRIC COMPANY'S 1920 REPORT.

The report and financial statement of the Canadian General Electric Company for 1920 was extremely satisfactory, showing record profits. The position of the Company and its business prospects are summarised by the President, Senator Nicholls, in his address to the shareholders, in part as follows:

Your Directors in submitting their Annual Report for the year ended 31st December, 1920, have pleasure in drawing attention to the fact that the past year has been one of the most progressive and prosperous in the history of the Company.

In the Annual Report for the year ended 1919 our Shareholders were advised that owing to the period of reconstruction which ensued after the Armistice conditions were far from encouraging, but that during the last six months of 1919 our orders exceeded any similar previous period. Fortunately that growth in the volume of business accepted by the Company both continued and increased during the year 1920, and at the close of the year there were carried over uncompleted contracts amounting to seven and a half million dollars.

In our last Annual Report, Shareholders were advised that owing to the manufacturing and distributing facilities of the Company being overtaxed additions and extensions had been authorized. These are now practically completed and equipped, at a cost of $1,890,775.81, and will enable us to manufacture to greater advantage. The total floor area of our several manufacturing plants is 2,055,464 square feet, and our Pay Roll for 1920 amounted to over $6,000,000.00.

The outlook for the electrical industry is most promising, as the demand for hydro-electric power is greatly in excess of the supply. The reason for this condition, favorable to the electrical industry, is because the use of electric power leads to more economical operation of industries and public utilities, and the convenient use of numerous household appliances for heating, cooking, lighting, etc. A survey of Canada's available water power shows nearly 20,000,000 horse power available, of which only about 2,000,000 horse power has been utilized, but other powers will be developed as the need arises, and will afford a growing and continuing market for electrical machinery and appliances.

Senator Nicholl stated that after 33 years of service he desired to retire from the responsible duties of President and General Manager of the Company. He mentioned that the original syndicate from which the Canadian General Electric Company had sprung had a capital of $10,000, and that the assets of the Company at this time exceeded $31,000.000.

The financial results of the year's operations may be gauged from the following figures

	1920	1919	1918
Gross Profits	$2,213,731	$1,617,989	$2,013,997
Net earnings, after deducting depreciation, interest and dividends	1,216,689	953,321	1,296,484
Common Stock dividends	874,114	640,000	640,000
Surplus	778,672	836,098	1,112,777
Per cent earned on Common	13.89p.c.	11.92p.c.	16.21p.c.

Excess of current assets over current liabilities shows a slight declension in working capital as follows:

	1920	1919
Current assets	$16,081,604	$10,705,961
Current liabilities	8,698,973	2,563,364
Working capital	$ 7,382,631	$ 8,142,597

The Board submits for approval a 20 per cent stock dividend for holders of common stock.

Mr. A. E. Dyment succeeds Senator Nicholls as President, and Mr. J. J. Ashworth, who has for a long time been Assistant General Manager, is appointed General Manager. Mr. John A. Bremner, who has been Controller of the Company, becomes Assistant General Manager.

IRONSTONE DEPOSITS OF NORTH LINCOLNSHIRE, ENGLAND.

During the war period, under the spur of necessity, British ironmasters availed themselves to a surprising extent of the Jurassic ironstones that are found in the Frodingham district. Recent reports refer to the proving of the Frodingham ironstone bed at Elsham, in North Lincolnshire, with the full seam thickness 29 ft. 6 ins. at a depth of 475 feet. The new ironstone find is only ten miles from the Immingham Dock at Hull. It is described by Professor Kendall, of Leeds University, as a most valuable discovery. Messrs. Lysaght are interested in the area.

Electric Annealing and Heat Treating Furnaces*

By GEORGE P. MILLS,
Electrical Engineer, Electric Furnace Construction Company, Philadelphia.

The heat treating processes to which the nichrome resistor type of electric furnace is particularly adapted are defined in the following paper. The design of this type of furnace is discussed, consideration being given to the mechanical structure, heat insulation and temperature control. Operating data is given on several typical installations and the probable trend of new applications pointed out.

In order to better appreciate the present status and future possibilities of the electrically heated furnace as applied to the annealing and heat treatment of steels, it might be well to consider, briefly, these processes from a metallurgical point of view.

Although annealing, hardening, quenching, and drawing or tempering are familiar terms, I would like to define them for the purposes of this paper, in order to outline the field of the electric heat treating furnace to better advantage. All of these processes, of course, involve heating the metal up to temperatures which depend on the analysis of the steel, holding at these temperatures a certain period and cooling at varying rates.

The term "annealing" may be sub-divided into three headings:

Normalizing.

First.—Normalizing, which consists of heating the steel either above or just below the critical temperature of the steel, removing from the furnace and cooling in air. This process when applied to steel castings, relieves the casting strains, brought about by uneven cooling when the castings are stripped and eliminates the hard spots, which make machining difficult.

Straight Annealing.

Second.—Straight annealing, which consists of heating above a critical temperature and holding for a short time, then cooling slowly by cutting off the heating medium and allowing the material to cool with the furnace. In continuous or semi-continuous furnaces, the material passes through a cooling chamber, so that the heat content of the heating furnace walls is retained, economy improved and production greatly increased. This treatment is used to turn out the highest grade of steel castings. Not only are the machining qualities of the castings improved, but the elongation is greatly increased at only slight expense of the ultimate strength. This form of annealing is also applied to tubes, wire, strip steel and other products that are cold rolled or drawn, in order to relieve the strains set up due to cold work.

Dead Annealing.

Third.—Dead annealing, which consists of heating the charge, soaking it a considerable time at the temperature, then coming in the furnace at a predetermined rate, say 5° or 10° per hour. This process is used on high carbon alloy steel such as ball bearing stock and other classes where absolutely uniform hardness tests are required. One reason for requiring this class of treatment is the finishing of the product in automatic machines, where any variation in the hardness might result in spoiled work and decreased production.

Hardening.

The hardening process consists of heating the metal to above the critical point and quenching. The degree of hardness depends on the rate of cooling in the quenching. The more rapid the cooling, the harder and more brittle will be the steel.

Tempering.

Tempering or drawing consists of reheating steel which has been quenched to a temperature below the critical point, varying from 450° to 1150° F., depending on the characteristics desired and cooling in air. The object of tempering is to eliminate the strains set up in quenching, render the steel more ductile, while retaining the high tensile strength produced in quenching.

Various physical characteristics can be obtained in a given steel by varying the temperature and the time element of treatment. Another important consideration in most if these treatments is that while it is essential to carry the temperature above the critical point, it is very desirable to keep very near the critical. Any excess above that actually required, tends to coarsen the finished product. In some types of furnaces where it is impossible to determine just what is going on in the furnace, it is a usual practice to run the temperature 50° to 100° F. above the actual critical as a factor of safety. In hardening and annealing, excessive time is usually allowed for soaking, in order to be quite sure that the entire mass of the part to be treated is up to temperature.

From the standpoint of the temperature and time element control, the electric furnace is ideal and is being considered in all cases where exceptionally high grade material is to be turned out. Other characteristics of the electric furnace are also being brought to the steel manufacturers' attention and undoubtedly, large installations will shortly be made for the production of less expensive material.

Electric Furnace Design.

The electric furnace, of the nichrome ribbon resistor type as shown in Figure 1 consists essentially of a strongly fabricated steel shell with a heavy thickness of high grade heat insulating brick, laid in three or four courses, with all joints broken. The firebrick lining of the furnace is bonded to the heat insulating brick so as to produce a solid rugged furnace wall of from 13 to 20" thick. The heating element consists of nichrome ribbon, which is exceptionally heavy and rugged. These ribbon elements are distributed over the inside walls and in some cases, the roof of the furnace, on insulating hanger brick which are built into the firebrick lining.

Heating Elements.

A single length of ribbon consitutes each phase. Where splicing is necessary, the joint is heavily reinforced and welded. The phase terminals are brought

*Delivered November 6, 1920, before the Philadelphia Section, Assoc. of Iron and Steel Electrical Engineers. Engineers' Club of Philadelphia.

through the furnace walls in close fitting insulating bushings to connection blocks on the outside of the furnace. The phases may be connected either delta or Y to the power circuit, through the control panel. This type of heating unit was developed some four years ago, by engineers of the General Electric Company at Schenectady. As to the ribbon, there are furnaces which have been operating for over two years day in and day out, and the ribbon shows no deterioration. An interesting example of the lasting qualities of the nichrome heating element is cited in the gun treating furnaces which were installed by the Government at the plant of the Tioga Steel & Iron Company, Philadelphia, early in the war. After operating a year, shortly after the Armistice, these furnaces were dismantled, ribbons straightened, shipped to Charleston, W.Va., reformed and built into new furnaces of a different size, at the Naval Ordnance Plant, and are now in operation. This is a positive proof that not only is there no reduction in area of the cross section of the ribbons due to erosion, but there is also no deterioration or crystallizing of the structure of the ribbon.

Maintenance and Repairs.

In fact, the maintenance and repair charges on the ribbon resistor type of furnaces installed, have been negligible. This is the logical result of the working out of the principle and design of this type of furnace. It is the simplest of all types of furnace form a construction standpoint. No combustion chambers, flues, port holes, false bottoms or double arches whatever are involved. The hearth, walls and roof, all being solidly constructed, can be insulated to the best advantage, to prevent loss of heat. At the temperatures involved, the maximum never going higher than 1800° F., the firebrick used, as well as the hanger brick, have a coefficient of expansion very nearly zero. The result is a tight furnace, in which all mechanical strains are reduced to a minimum. The lining does not crack, spall or run. These facts are important, of course, not only from the standpoint of small maintenance costs, but there is no lost production due to shut-downs for repairs. Due to the fact that the ribbon resistor may be formed in any reasonable shape and distributed over the interior of the furnace, remarkably uniform temperatures are obtained throughout the furnaces.

Fig. 1 Electric Carbonizing Furnace.

Heat Distribution.

The ribbons are distributed so that extra heat energy is dissipated inside of the furnace at the points requiring the most heat, in order to maintain uniform temperatures.

Large Installation.

An example of this is shown by the gun treating furnace now being installed by the Electric Furnace Construction Company, which has inside dimensions of 36′ deep x 6′ in diameter, has a capacity of four 6″ naval gun forgings weighing 50,000 pounds per charge. The furnace is divided into six heating zones, each controlled by an individual automatic panel. The radiation losses on the bottom and top zones are greater than on the intermediate zones, also the amount of metal to be heated is greater in the top and bottom zones than the intermediate zones. For this reason, 138 kilowatts is installed in each end zone and 110 kilowatts in each of the intermediate zones, the total installed capacity being 716 kilowatts. This arrangement insures uniform temperatures in the gun forgings throughout their entire length at all times, both during the period required for coming up to temperature and during the soaking period.

In the smaller furnaces where a single control is used, additonal heat is generated near the doors by doubling the heating element back for a short distance, thus developing twice the B. T. U.'s in this portion of the furnace where the radiation losses are greatest.

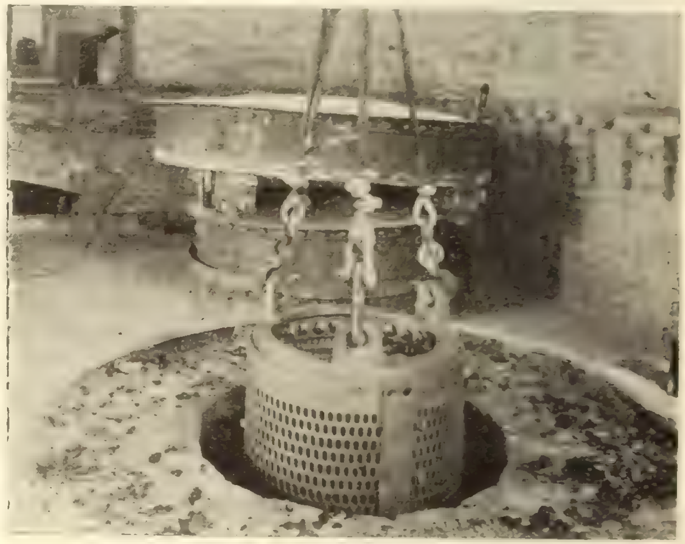


Fig. 2.
Semi-centrifugal annealing-furnace for small steel castings. Showing lowering of container-cage into furnace. Soaking pit in background.

Temperature Control.

The temperature control which is the most important feature of the electric furnace is operated by the "on and off" principle, that is, power is cut off when the temperature of the furnace reaches a predetermined setting and is cut on again when it falls to a predetermined setting. This operation is accomplished by means of thermo-couple which is placed on the surface of the charge, actuating a recording controller. The sensitivity of the control instruments is plus or minus $\frac{1}{4}$ of 1 per cent. of the range of the chart, that is, if the chart of the instrument has a scale of from 200° to 1800° Fr., the chart range would be 1600° and the sensitivity of the instruments would be $\frac{1}{4}$ of 1 per cent. of this range of 4°

The "on and off" principle of temperature control has a number of advantage over the variable voltage control, in that the heating elements are designed for operation on standard power voltages—110, 220, 440 or 550 on either single, two or three phase, 25 or 60

cycle or D. C. Often, excess capacity in the existing power transformers can be used to advantage in the electric furnace. In cases where additional transformers have to be installed to take care of the furnace load, these transformers are of standard type and may be purchased to line up with existing power transformers.

The fact that the old load is thrown on an off suddenly will produce no disturbances in line. On large furnaces as in the case of the gun furnace just cited, the power is controlled in sections so that only a small part of it is actually thrown on or off at any given instant. The usual maximum of a single zone is somewhat less than 250 kilowaats. The chief advantage of this method of control, however, is that is is entirely outomatic; and eliminates the manual operation which is necessary in rheostatic or transformer tap control.

Accurate Temperature Measurement.

The temperature control of the electric furnace is unique, in that the actual temperature of the charge is measured within the accuracy, of course, of the thermocouple. This is due to the fact that the atmosphere in the electric furnace is dead and the charge and furnace

Fig. 2.—Electric annealing-furnace, soaking-pit and control-panel in operation.

are brought to temperature by radiant heat. In the case of combustion furnaces, the charge is heated by being surrounded by rapidly moving gases which necessarily requires a high temperature gradient between the moving gas and the charge. In the majority of cases, the thermo-couple of the combustion furnace is located so that hot gases impinge on it, and the temperature of the gas, and not of the charge, is recorded. For this reason, it is often necessary upon the installation of an electric furnace to reduce the apparent temperature at which the work is treated.

Rate of Change Controller.

An intersting instrument, known as the rate of change controller, has been developed in conjunction with electric furnace work, so that an entire cycle extending over a period of 144 hours or longer, may be automatically controlled. The use of this instruments is contemplated for the annealing of ball bearing steel —carbon, 90 to 110, chromium 115 to 130, where the following cycle is required: The steel is brought tc temperature and held for forty-eight hours, then cooled at the rate of 10° an hour to 900° F. then at the natural cooling rate of the furnace to 600° Fr., when it is withdrawn and a new charge put in.

When using the rate of change controller in connection with the electric furnace, the entire operation after closing the control switch at the beginning of the cycle is carried out automatically. On the furnace mentioned, it is contemplated bringing the charge and furnace up to 1440° in eighteen hours, so that in order to get a soaking of 48 hours, it is necessary to set the rate of change instruments to begin operation 66 hours after starting up. The temperature setting of the instrument is then automatically reduced at a uniform rate of 10° per hour until the 900° F. is reached. During this cooling period of 54 hours, the heating elements are energized only a small portion of the time, being just sufficient to make up the radiation losses in excess to what would be equivalent to the cooling rate of 10° per hour. At the end of the 54 hour cooling period, the power is automatically cut off the furnace and it cools at the natural cooling rate until 600° F. is reached.

Other Advantages of Electric Furnace.

In addition to its ruggedness, and automatic control features, there are many other characteristics of the electrically heated furnace that are so well known as to need only brief mention.

By its automatic functioning, with electric power at

Electric Core and Mould-baking Oven.

its heating element, the fuel question is eliminated. The consideration of this item alone could be made the subject of a separate paper.

The character of the load is ideal for the power station in that it is balanced and of unity power factor. The load factor is high and in some cases the heating cycle can be arranged so as to use off peak power, althought the most efficient operation is on a 24 hour basis.

The space occupied by the furnace is small compared with other types, especially when account is taken of the space required by fuel fired furnaces for accessory apparatus and fuel storege.

The working conditions around the electric furnace are excellent. It is cool and there are no fumes, no dirt, no noise.

There have been installed or contracted for, up to the present time, aproximately 12,000 K.W. capacity in ribbon resistance type of furnaces, for temperatures of from 1000° to 1800° F.

Typical Installations.

Some of the typical installations are described.

The four 400 K.W. furnaces installed at, the Tioga Iron and Steel Company, Philadelphia, are 22½" high and 6′ in diameter. The two furnaces adjacent to a quenching tank are operated at 1500° F. for hardening, while the two are used for drawing at 1150°. Each of these furnaces have four control zones, each connected to the power circuit throught its individual control panel. The control panels are located together in the electrical sub-station room, which is adjacent to the furnace room.

Each panel carries a controller recorder, contactor, operating relay, pilot lamps, control switch and fuses. On the new panels the fuses are replaced with overload relays.

Charges approximating 25,000 pounds have been run through these furnaces at 1450° F. with a current consummation of 170 K.W.H. per ton. This is equivalent to an operating thermal efficiency of 76 per cent.

Figure 2 outlines the principle involving in a casting annealing furnace recently installed by the Electric Furnace Construction Company at the Emery Steel Castings Company, Baltimore. The equipment consists of one heating furnace, one soaking pit, two containers and one cover. The small castings are placed in the container and lowered into the heating furnace. When up to temperature, the cover is lowered over the container. The cover fits into a sand seal on the bottom of the container, effectively excluding the air while the charge is raised from the heating chamber and lowered into the soaking pt. Another container full of castings is immdiately lowered into the heating chamber and the cycle repeated; the charge in the soaking pit cooling slowly while the second charge is coming up to temperature.

Figure 3 shows a general view of the plant in operation. The capacity is 46 KW. and has an output of approximately three tons per twenty-four hours. When operating on this basis, the power consumption will be about 200 KWH. per ton of material charged.

The Emery Steel Casting Company also has in operation a mold baking oven 6′ to 10″ wide x 12″ long x 6′ 4″ high and has a capacity of 126 KW. The oven has an output of one thousand 6″ x 8″ x 12″ molds per twenty-four hours, at an energy consumption of approximately twelve pounds of molds per KWH. In addition to the automatic control panel, a second panel containing the thermostat and watt hour meter is installed alongside the oven.

The fact that the KWH. input for each electric furnace or oven can be metered and therefore the cost of operation accurately obtained, is one of the advantages gained with use of this apparatus.

Another important application of low temperature ovens is typified by a very successful installation at Halcomb Steel Company for drying wire after it comes from the pickle. The wire is dried at 350° F. with a power consumption of about 83 KWH. per ton.

New Development.

Considerable experimental work has been done on an electrically heated furnace for treating large armor piercing shells. A design for this type of furnace has now been perfected, which is essentially a refinement of the pit type furnace illustrated in Figure 3. The shell furnace is divided into three control zones, to that the temperature may be brough up evenly, notwithstanding the fact that the section of the shell varies along its length. Each zone is connected to one phase of a three-phase circuit and thetemperature is controlled by a double point recorder-controller. The zones are separated by ni-chrome casting, which acts as buffer guides for the shell.

An interesting layout has been made of a furnace for the annealing of 120 tons of steel castings per twenty-four hours. This furnace will consist of two parallel heating chambers each 8′ 6″ wide x 44′ long. On each end of the heating chambers will be a common recuperative chamber 18′ wide x 22′ long. The castings will be carried on cars 7′ wide x 11′ long which will pass through the heating chambers in opposite directions. The cold incoming charges being preheated by the hot outgoing charges in the recuperative chambers. At each end of the furnace is a transfer table and a self-contained motor driven hydraulic pusher.

On each side of the furnace, there will be two cars preheating, four cars in the heating chamber and two cars cooling. Each car will be in the heating zone two hours and one hour in each of the recuperative chambers. Seventeen (17) cars will be used in the operation of the furnace, eight in each side and one unloading and loading.

The method of operation consists of setting both transfer tables opposite the ends of No. 1 side of the furnace. On the table opposite the incoming end is a loaded car. The dors are opened and pusher advances the string, over car length, discharging a finished car on the other transfer table. Fifteen minutes is allowed for unloading and re-loading. The transfer tables are moved opposite the ends of side No. 2, where the operation described for No. 1 side is repeated, thus a finished car will be produced by the furnace every fifteen minutes.

The total connected load of the furnace is 1885 KW. and this is divided into eight control zones, four in each heating chamber.

Much thought has been given to furnaces for roll hardening, malleable annealing, baking carbon electrodes and similar processes, requiring temperatures up to 1800° F. On account of the flexibility of the electrically heated furnace, the principle may be readily applied to any of these processes.

Two important considerations to be taken up in the laying out of a new furnace are:

(1) The relation of the size of furnace to the output. The electric furnace should be loaded to capacity at all times. If the production is expected to vary widely, two or more furnaces should be installed to insure capacity operation on the one that are running.

(2) Handling equipment and devices should be coordinated nicely with the furnace. High grade work can easily be spoiled in handling from the furnace regardless of the fact that the furnace itself might be working perfectly.

It is the function of the furnace engineer to investigate thoroughly, all the conditions pertaining to a proposed installation before making recommendations, and this, of course, can only be well done when full cooperation is given by the operating engineers. Much of the progress that has been made in the electrometallurgical field in melting, refining and heat treating may be credited to electrical engineers associated with the steel plants, and the progress which is made in the future in the use of this latest perfected electric furnace largely depends on the interest taken in it by technical organizations.

The Relation of the Underground Loading Machine to the Mining Industry

With Special Reference to Experiences with Mechanical Loaders in the Iron Ore Mines of the Dominion Iron & Steel Company at Wabana, Newfoundland.

(A paper by Hugh B. Gillis,* presented before the Mining Society of Nova Scotia at the Annual Meeting in Halifax, April 5th and 6th 1921.)

The industrial progress of Nova Scotia depends in a greater measure upon low coal-mining costs than upon any other single factor. The heavy increase in miners' wages made during the past six years has imposed a burden on the industries of the province that must be relieved by corresponding reductions in wages or counteracted by improved and cheaper mining methods before Nova Scotia can secure that share of the World's trade to which it is entitled by geographical position and the abundance of mineral wealth.

The coal mining industry of Nova Scotia is in direct competition with the product of American mines, where coal can be mined from strippings or sidehill openings at a cost not much greater than the development and overhead charges against our product. We not only must compete with this cheap coal in the coal markets of central Canada, but must compete with it indirectly in all branches of manufacturing. In the steel industry this competition is most severely felt, for, while other branches of manufacturing can be carried on with the same ratio of fuel consumption to the unit of product as prevails in the United States, the steel industry of Nova Scotia has a greater fuel usage per unit of output of its mills than similar operations carried on at American plants.

Cost of Fuel the Key to Successful Steel-making in Nova Scotia.

These conditions are generally recognized and accepted as inevitable by all who have studied our industrial problems. The coal supply is conceded to be the key to the situation and on the cheapness of this supply depends the success of our industries. Up to a few years ago, when our mines were required to meet only the normal increases in operating costs due to comparatively small wage increases and to a gradual recession of the working places from the pit mouth, the task of maintaining a reasonable cost was simple and consisted in introducing more efficient equipment and in opening new collieries, where the low initial operating-cost (for a time) assisted in bringing the average production cost to a point where the normal increase was apparently offset. At present none of the former expedients seem to offer a satisfactory solution of the difficulties arising from prevailing high labour rates. Our mines are equipped with modern ventilating, pumping, hoisting and coal-cutting machinery, and the opening of new collieries would be of little assistance, as any output from this source would form such a small proportion of the total production of the mines that the effect would be negligible.

The problem of coal-mine operation today is to devise a method of mining coal and getting it to the surface at a cost that will permit its sale at competitive points and will also enable local industries, not having the advantage of a location making possible the importation of cheap foreign coal, to continue without the handicap they are suffering from at present.

As labour seems to be the most acute problem, any effort to reduce mining costs must essentially be directed to increase the returns per labour unit expended. If it is assumed that the present labour out-turn is the maximum to be expected under the present method of mining and with present equipment, operators will be driven, by necessity, to the devising of new mining methods, providing labour-saving machinery; or adopting a combination of both of the foregoing, so that a larger labour out-turn may be secured, before much improvement can be looked for in the cost sheet.

There is one large labour-absorbing process that for years had not received the attention its bearing on the cost sheet deserved. Hand loading is still followed as in the days of the Duke of York's Lease and, while in past years there was the excuse that no adequate substitute was available, its continued practice in the face of the progress made in the last few years will, within a very short period, be a reproach to any mining man responsible for that continuance.

During the past ten years manufacturers of mining equipment have given a great deal of thought and expended a large amount of money in perfecting efficient underground loading-machines. During this period mining operators were suffering by the so-called inefficiency of labour. The high wages prevalent in the mining industry added to their difficulties by creating a holiday tendency among miners receiving large pay-envelopes. Manufactureres naturally assumed that a suitable machine that would efficiently replace the large number of shovellers underground would be welcomed generally by the mining industry. As a consequence there was expended in experiments and tests, a sum estimated to be in the vicinity of ten million dollars, and as a result there is on the market a large number of loading machines. It is not intended here to discuss the various types of machines now being offered, only to say that these present so many different principles of design, construction and operation that almost any loading problem can be met by one or more of the machinery now being manufactured.

Trials of Mechanical Loaders at Wabana Iron-Ore Mines.

For the past two years the Dominion Iron & Steel Company has been operating two self-propelling mechanical loading-machines at its iron-ore mines at Wabana, Newfoundland. The introduction of these machines was due to a scarcity of labour and the tendency of the men to take pay-day holidays and week-end jaunts. It was hoped that these units would tend to balance output and stabilize costs by furnishing a tonnage that would in some small degree offset the otherwise high "idle-day" cost.

The mining methods in operation when the machines were installed were as follows:

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The mine was operated by the ordinary room-and-pillar method from a slope driven along the dip. The grade of the main slope was fifteen per cent. The rooms were twenty-five feet wide and driven at fifty-feet centres, slightly to the rise, to give a grade of one and one-half per cent in favour of the load. The cars used were 3 ft. wide, 2 ft. 5 ins. high (from top of rail) and 6 ft. long, and held 1.7 tons of ore. The track guage was 24 inches. The main slope was double tracked, and each side was operated by a separate haulage-engine. The ore was hoisted, in trips of seven cars each, on the main slope. On the main levels head and tail haulage-systems were installed and cars were spotted at working places from engine gravity-planes in back deeps, augumented by horse or hand-tramming. In practically all cases it was necessary to tram by horse or hand upwards of one hundred feet from the power haulage to the working places.

After investigating several makes of machines, all of which were more or less suitable for the conditions, it was decided to install two Myers-Whaley No. 4 Shovellers. This machine is of continuous-stream type, and consists essentially of an automatic shovel, mounted on the forward end of a jib, carrying a reinforced conveyor-belt upon which the shovel discharges its load. The unit has an overall length of 26 feet, a height of 6 feet, and weighs about 9 tons. It is made up of three parts, the main truck, the front conveyor or jib, and the rear-conveyor. On the front end of the jib is carried the shovel, while the rear end is pivoted on the main truck to permit the whole jib and shovel to be swung through an arc of 45 degrees on either side of the track. The rear conveyor, which receives the material from the jib conveyor, is also pivoted, and swings 20 degrees on either side of the centre line. The machines are actuated by 20 h.p. motors, and from the operating platform attached to the jib the operator can control all movement. The shovelling mechanism is probably the most striking feature of the unit. It is made up of two parts, dipper or shovel, and a transfer box. The dipper is moved and supported in front by a crank-shaft, rotating continuously in one direction, while the rear end is supported on a cross shaft carried on rollers running in cam grooves. This controls the motion of the dipper and makes it almost identical to the motion of the ordinary hand-shovel. The front part of the shovel or dipper discharges its load into the transfer box, also carried on rollers in cam grooves, which tips the box each stroke and empties its load on the jib conveyor. The dipper crank makes about twelve revolutions per minute. The power consumption of the machine when loading at capacity is about .25 k.w. hour per ton of material handled.

Without making any change in track guage, size or type of car or in the general system of tramming, it was found that the loading machine would load out from 120 to 140 cars per shift of ten hours. With the cars holding 1.7 tons as an average load, this gave an output of from 204 to 238 tons of material per machine per shift. These machines, operating under conditions not specially designed for them, have loaded ore at a labour cost of thirty per cent of hand-loading cost. This loading cost includes the labour of five men, only one of whom should be charged directly to shovel operation. However, our costs are computed on a five-man basis and include charges for the operator, two trammers and two trackmen. The average tonnage per hand loading under similar conditions is sixteen tons per shift, so that from one room a mechanical shovel loads out a tonnage equal to eight pairs of hand loaders. The number of trammers and trackmen required in both cases is the same. The maintenance and interest charges on the loading machine increase the cost from thirty per cent to sixty per cent of the hand-loading cost. There is therefore a direct saving of forty per cent in the cost of loading by doing the work mechanically. The loading performance of the shovels operated under conditions existing in the mines at Wabana does not approach the maximum that could be obtained by adjusting underground conditions to supply ore and cars to the shovel at its normal loading-rate. The actual time of loading a car rarely exceeds one and one half minutes, and cars have been loaded in forty-five seconds. It might appear too much to expect to maintain a loading speed of one car per minute for an entire shaft, as this would mean moving about one thousand tons of material, but the actual performance is so far below what might be considered as the limit of the machine that we are seriously considering revising our mining and handling methods to give the loaders every possible advantage. At present the machine is limited by the tonnage of ore broken per room. The average room, with a section of ten feet ore, is broken to a depth of 10 feet and approximately 250 tons of ore shot down. This could readily be increased but other limiting conditions would immediately become operative, the most serious of which would be the tramming limit, which, under the present backward and forward movement of cars, appears to be about fifteen cars per hour.

Trials Indicate Possibility of Great Economies.

Our work with these machines has been, and still is, rather more in the nature of tests or experiments to determine their possibilities than a straight operating proposition. The trials have indicated that, by the general introduction of loading machines where large tonnages are handled, there are possibilities of economy in cost and labour approaching in magnitude those effected by the application of the well-known steam shovel to loading work on the surface. These economies can only reach their maximum by the full support and co-operation of mining men. There must be a realization that a unit such as a mechanical loader, capable of doing the work of fifteen to twenty men, calls for suitable mechanical auxilaries to enable it to perform its maximum work. To expect a mechanical loader to operate efficiently under conditions of breaking and tramming primarily intended for hand loaders, would be as reasonable as to look for efficiency from a surface steam-shovel where the material is supplied by the shooting of hand-drilled holes and removed in wheelbarrows.

The direct saving that may be effected by the general introduction of mechanical loaders is only a fraction of the greater economy that would follow their use. From our experience at Wabana it is found that an output can be obtained from one working-place equal to the tonnage recovered from eight places loaded out by hand shovellers. Under hand-loading conditions for an output of 2,000 tons per day we find it necessary to employ about 60 pairs of loaders. This calls for the maintenance of about 80 working places or a total working-face of 2,000 ft. On the other hand, we estimate that the machines would give the same

output from 10 working places or 750 ft. As there would be only 10 rooms working each day, the reduction in the general force, such as face-cleaners, blasters, foremen, trackmen, trammers, etc., would be reflected in the cost by a decided decrease. The diminished working-area will show a decided reduction in development and maintenance charges. The concentration of work will render supervision easier and increase the general efficiency. By the reduction of force the heavy charges for employees' housing can be greatly reduced, and the coal now supplied to workmen, who would be replaced by the machines, would be available for sale. With fewer men employed underground for a given output the protection of the worker from accident is simplified. The output from a mine when loading is done mechanically, should be more constant and regular than from a mine where hand loading is followed.

If these analyses of the situation are correct it is evident that the mechanical loader will evolutionize mining costs. The statements above have been based on our Wabana experience, but they apply with equal force to coal mining and all underground work where material must be moved from the mine floor into cars. It will be remembered also that our experience has convinced us that up to the present we are not getting the best possible results from the machines. By taking full advantage of the maximum loading capacity of these machines and laying out the mine workings and supplying adequate car-capacity a much greater output per machine can be obtained than the 250 tons per day that has been secured. With a constant stream of cars supplied in one direction it would not be too much to expect an output of 1600 cubic feet of loose material per hour, which would be equivalent to 94 tons of ore or about 40 tons of coal from each machine.

Special Underground Conditions Required for Mechanical Loaders.

To apply these machines successfully to the problems of loading, miners must first of all realize that conditions favourable to their use must be created underground. As practically all failures, with carefully selected machines, have been due to an insufficient supply of cars to keep the machines constantly at work, it is apparent that there is a decided lack of interest or lack of appreciation of the nature of the loader on the part of mine superintendents. When small delays for cars occur where loading is done by hand the workmen can be employed usefully at some other work, and the rest or "spell" during the delay does not in all cases mean a decreased tonnage for the day's work. With a machine that cannot be employed at other work, or does not suffer fatigue, any delay encountered is a dead loss. This essential difference must be constantly remembered, and one of the first conditions of successful operation with machines is a continuous and adequate supply of mine-cars. The other consideration is a supply of broken material for loading.

Possible Adaptation to Coal Mining.

None of the present systems of mining in local collieries would permit the efficient use of loading machines similar to the Wabana units. To operate successfully, these machines must have not less than 300 tons of coal available for loading each shift. The tramming system must be such as will permit the handling of a sufficient number of cars to and from a machine to move this tonnage. The room-and-pillar system, or any of its local modifications, does not yield at any working-place the coal required to keep a loading machine employed more than a few hours.

The longwall system can supply the coal, but in only very special cases can conditions of roof be found to permit passage of cars along the working face. The space required by the shovel is 4 ft. 8 ins. and for car tracks about 4 feet additional, making a total distance between the supports and the face of 8 ft. 8 ins. If this distance is found excessive supports could be placed between the shovel-track and car-track. This would cut down the free roof to about five feet, a distance that it does not seem unreasonable to suppose could be maintained in practically all collieries.

If the necessary constructive thought is devoted to devising a method of breaking coal in sufficient quantity and supplying cars for its removal the writer is convinced that a mechanical loader can be operated successfully in a large number of our collieries. The possibilities offered by mechanical loading for reduction in mining costs are so promising that we cannot afford to dismiss them until these devices have been tested under the most favourable conditions. The necessary conditions are not those obtaining in our mines at present, but must be created. Until these conditions have been arranged, and a full working-test carried out, we cannot claim to have exhausted the possibilities of improved equipment and are ignoring what, in the writer's belief, is the only means available to counteract the drain the industry is at present suffering on account of high wage costs.

ENGLISH ELECTRIC COMPANY TO COME TO TORONTO.

The English Electric Company is announced by official cables from England to have decided to open a plant and offices in Toronto. Gordon C. Perry, President of the National Iron Corporation, has been named as Chairman of the Canadian board of the Company.

English Electric is a merger of only two years existence of seven large British manufacturers, namely, John Brown & Company, Harland & Wolfe, Dick Kerr & Co., Coventry Ordnance Works, United Electric Car Co., Willans & Robinson, Phoenix Dynamo Mfg. Co., Siemens Bros. & Co., and Siemens Bros. Dynamo Works. The character of the enterprise included in this list of well-known names makes the English Electric a very important enterprise, and the intention to locate in Toronto is a matter of first class importance. Evidently there are others, besides the far-seeing management of the Canadian General Electric Company that realize how great is the future of the electrical industry in Canada.

THE PLATE MILL AT SYDNEY, N.S.

The rolling of plates at the Dominion Iron & Steel Company's mill has been discontinued, and the staff has to some extent been dispersed, as no immediate business is in sight.

The contract between the Canadian Government and the Company has been cancelled by the Government, and acording to a statement made by the Minister of Marine in the House at Ottawa, the compensation due to the Dominion Company for cancellation will be assessed by the Exchequer Court.

THE LATE MR. C. E. DUNCAN.

(From "The Algoman," Sault Ste. Marie)

.... " **The elements so mixed in him, that nature might stand up and Say, to all the world: 'This was a man'.**"

The words of Shakespeare might fittingly be used as an epitaph over the tomb of our friend and co-worker, Charles E. Duncan, late General Superintendent, who, on the 26th ult., tore asunder the impenetrable veil separating us from the Great Beyond and passed out, America's greatest practical Steelman.

Yes, Charlie Duncan was a man—a big man, big in mind, big in conception, big in viewpoint, — big in vision, big physically, big no matter how you looked at him. He was bigger even that the job he held—and the writer ventures the view that that's one of the biggest jobs, if not the biggest, in the whole Algoma Steel Corporation, just at the present juncture. For, with the world money marts gone blooey, markets tottering, changing, selling prices tobogganing from the emin-

THE LATE MR. C. E. DUNCAN

ence which was the low point of yesterday, to a new cellar position which, in turn, was to be the eminence of the morrow; with the price of raw products constantly soaring; with the steel world in a paroxysm trying to recover from its war time carouse—his was the task, of all others, to hold firm grip at the helm of affairs hereabouts; his was the task to make the local situation readjust itself so as to fit in somewhat with the change in world conditions in the industry; his the task to throw off his coat, go out into the mills, study minutely every phase of operation—and get out production at a cost which would be calculated, somewhat, to meet the ever-changing situation. Higher executives might figure out, in a general way, what was required; they might generalize as to how this was to be done in the works; but, when it came to the actual doing of it, or deciding how, specifically, it was to be done; how to whip the various department heads into line, and how to co-ordinate their divers activities and operations to the general advantage—it was distinctly up to Charlie Duncan. It was a big job, we said; but Charlie was bigger than the job. He was the master millman—the master superintendent. That's why he was brought to Algoma, at a crucial time in the history of the works.

* * *

Imbued with that courage, which ever arises from a sense of duty, a sense of the importance of the task to be done, Charlie Duncan braved everything, in its performance—braved even the ill-will, even at times the revilements of a few of the more short-sighted, who could not, by any stretch of the imagination, realize the stupendous character of the task which had been saddled upon him. True, in his private and personal life, these latter hurt him, cut him to the heart—for he was a tender-hearted man, a sensitive man, despite his ruggedness. But, being a big man, a man of big vision, of wide vision, he, like every big man and man of big vision, had to forget self, to sacrifice his own feelings on the altar of his job, confident in the thought that he was right, that what he was doing was right and that the more farsighted would know that, if the works were kept running and the men had the wherewithal to keep themselves and their families together, it was due to his work. And results have shown that, thanks largely to his efforts, Algoma Steelmen, thus far, have weathered the storm better than many others in this industry, all over the continent.

* * *

To many, Charlie Duncan was a formidable man, a man hard to meet, hard to talk to; they feared him. But humanity being the peculiar characteristic of all great men, he was an eminently human fellow—in fact, a great big boy, in heart. True, he was gruff and abrupt, at times; his was a rapier tongue in repartee; he was a great judge of human nature and a great manager of men; he knew the steel game from top to bottom; he detested subterfuge and camouflage; it was useless to try to resort to such with him. They would'nt pass muster. He knew all the tricks. The only way to corral his interest and good will, was to go absolutely straight with him. Then he became your backer and friend and champion against all comers.

He dearly loved a fight, even for the fight's sake or to try out the mettle of a subordinate and he well nigh despised any one who feared him. He told the writer an incident illustrative of this, some weeks before he died. He said that, once, he had had occasion to give a department head a "raking over the coals" about something. This latter felt very badly over it and came to his office almost in tears, to explain the matter. "Do you know," he proceeded, telling of it, "I'd have thought ten times more of that chap, if he had burst open my office door, thrown his hat on the floor, jumped across my table and bearded me, saying, —'See here, Duncan, d—— you, what do you mean by jacking me up this way.'" Again, when our present General Manager, Jimmy Jones, was chief engineer, some years ago, he and Charlie would "count that day lost, whose low descending sun" had not witnessed a genuine set-to between them. In fact, many a time,

Charlie threatened to run Jimmy "off the works, for keeps"—only to forget all about it in the next half hour. The two were always the best of pals, largely, because Jimmie was never afraid of him and Charlie knew it. Neither would take back talk from the other. Hence they admired each other.

Now—to even a more human side of his character. There are not lacking those around the works who can testify to the depth and sincerity of Charlie's friendship—a friendship which stood by them in time of need. It is necessary to go only as far back as the January shut-down to get examples of his unobtrusive openhandedness towards many a needy workman and his family. Scores called at his home on east Queen street and none went away empty-handed. Whether it was with a gift of foodstuffs, an order on the grocer or butcher or the assurance of employment, all who applied and whose story rang true, were afforded relief.

Mr. Duncan's death was not entirely unexpected, but it nevertheless came as a shock to the wide circle of personal and business friends and acquaintances who held him in the highest esteem.

He became ill on Saturday, the 19th and it became necessary to perform an operation which took place in the General Hospital on the following Monday evening, the 21st. He was operated on by Dr. J. R. McRae and Dr. S. B. Casselman, while Dr. A. S. McCaig and Dr. J. R. McLean were also in attendance.

Mr. Duncan's condition at the time the operation was performed was, however, beyond medical science to relieve and he fought a losing battle against death. He rallied Tuesday morning, but suffered a relapse and the end came at 12.50 a.m. on Saturday, the 26th.

Mr. Duncan was forty-eight years of age. He was an American citizen, born in Chattanooga, Tennessee, but he lived in Johnstown, Pa., most of his life, where he began to make steel as soon as he was old enough to work. He started in the Homestead works of the Carnegie Steel Corporation, following in the same business as his father, and working in every department of the steel and iron business until he rose to be recognized as one of the best steel men in the country. At one time in his career, he was assistant general superintendent of the Bethlehem Steel Corporation, where he was personally esteemed by Mr. Charles Schwab the president of the company. Mr. Duncan knew the practical side of steel making, as few men do. He commenced his work with the Algoma Steel Corporation in 1909 and was general superintendent here until 1915, when he went to Donner Steel Company of Buffalo, N.Y., and thence to the Pacific Coast Steel Company of San Francisco where he was in the service of the United States government, which had taken over the plant. In April of 1920, when the late David Kyle died, and J. D. Jones, who at the time was general superintendent, was made general manager. Mr. Duncan was recalled and was engaged as general superintendent up to the time of his death.

The wide circle of friends who keenly regret Mr. Duncan's loss, regarded him as a man of unusual capabilities. He was broad visioned and possessed an almost uncanny knowledge of steel, being able for example, to tell at a glance the analysis of the steel. He was a man who could mix on intimate terms with the most prominent executives in the business and the ordinary workers in the mill.

He was a well proportioned man, physically and mentally, and regarded with respect by every one who made his acquaintance. The officials of the Algoma Steel Corporation, especially, regret his decease, as he was an invaluable member of the executive Staff.

He is survived by his wife, a son, Ellis, of Johnstown, Pa., his mother, two sisters and a brother, the four latter also of Johnstown. His father, J. M. Duncan, predeceased him by only three weeks.

Funeral arrangements were in the hands of the officials of the plant. Burial took place in Johnstown, whither the body, accompanied by officials of the Corporation, was shipped.

ANOTHER EXCELLENT SHOWING BY STEEL COMPANY OF CANADA.

"Iron & Steel of Canada" took occasion to comment, when the Steel Company of Canada issued its report for 1919, on the evident competency of the management of the Company, judged from the nature of the 1919 report considered in the light of the adverse conditions of that year. The report for 1920, showing earnings of 11.7 per cent on the common stock, must be considered as most satisfactory, seeing that the depression in the steel business had set in by the middle of the year. Figures for the year 1920 compare with two previous years as follows:

	1920	1919	1918
Gross Profits	3,924,041	4,000,940	5,367,120
Balance after deduction of depreciation, sinking funds, bond interest, and preferred dividends ..	1,400,663	1,927,430	1,957,017
Common stock dividends	805,000	805,000	690,000
Surplus	595,663	1,122,430	1,285,017
Balance at P. & L. ..	$8,740,965	8,195,302	7,322,872

The deductions from the gross figures of 1920 included $652,255 intended to cover excess costs of construction occasioned by the abnormal prices of 1920. The amount standing to credit of Profit & Loss at the end of the year, namely $8,740,965, is equivalent to 48 per cent of the combined total of the Company's preferred and common stock issues.

The financial position of the Company is very liquid, quick assets, including $1,670,000 of cash and call loans, standing at $10,700,000 approximately

In regard to appraisal of inventories, and the conditions of 1920, the president, Mr. Hobson, stated in his report:

Inventories.

"Inventory prices in all classes of manufacturing concerns this year are of serious import and, consequently, great care was taken in valuing our inventory, and the figures which we have shown on the statement we believe to be fair and proper. Realizing price declines were in prospect, we aimed during the latter half of the year to keep the inventory down as low as possible and, as business was quite active in most lines almost to the close of the year, we were able to bring our inventory, as at December 31, below that of last year."

Conditions During 1920.

"While the results of the year, we believe, will be considered very satisfactory, it is only right to point out that they were achieved under many adverse conditions.

"Increased freight rates were imposed both in Canada and the United States and the average rates we

now have to pay are fully 100 per cent. higher than they were before March, 1918. Labor conditions were not as satisfactory as they should have been, considering the high rates of wages that we were paying. The rates of exchange paid on coal, ore, etc., purchased in the United States, were high during the year.

Fuel Supply Serious Handicap.

"Our most serious trouble was the matter of fuel supply. The whole continent was affected. The shortage was so great that we, like all other steel producers, could not get anything like our full requirements. The shortage was due almost entirely to the car supply. We had our own mine to draw from and had early in the year placed contracts with other companies, but notwithstanding these precautions, we were forced to buy spot coal at high prices. Even after using our best endeavors, we were able to secure only sufficient coking coal to keep one of our blast furnaces in full operation throughout the year. With the exception of our blast furnaces, all the other plants were kept fully occupied.

"Against these adverse conditions we had a large demand for our goods at profitable prices. In October, however, new business began to fall off, but our booked orders enabled us to run full until about the middle of December, when we found it necessary to begin to reduce operations very materially. At the time of writing this report, steel business everywhere is much below normal."

BOVING HYDRAULIC & ENGINEERING CO.

Contract has been awarded by the Hydro-electric Power Commission of Ontario to the Boving Hydraulic & Engineering Co., Ltd., of Lindsay, Ont., for two 5,000 h.p. vertical shaft, single-runner, hydraulic turbines for the Ranney Falls development on the Trent Canal near Campbellford, Ont.

SPRING MEETING OF THE AMERICAN ELECTRO-CHEMICAL SOCIETY AT ATLANTIC CITY.

The forthcoming meeting of the American Electrochemical Society, to be held at Atlantic City, April 21-23, promises to be one of unusual interest. One feature of the technical progress will be a Symposium on Corrosion. The fact that the corrosion problem is receiving wide consideration is manifested by the numerous papers contributed to this Symposium. That iron rusts has been common knowledge for centuries, and many of the factors which control its rate of corrosion have been understood for some 20 years; nevertheless, rust-eaten iron and steel work is an all too common sight—all because more iron and steel can be obtained to replace that corroded. The situation is not an excusable one since the cost of replacing steel work is often far in advance of the cost of the material itself. Some types of non-ferrous corrosion will also be brought up for discussion and the arrangements for the program necessitated extending the Symposium over nearly two morning sessions. This Symposium should throw some new light on this all-important problem as well as brighten the future out-look for [illegible]

The corrosion Symposium will be succeeded by the presentation and discussion of papers on experiments and more recent developments along electrochemical and electrometallurgical lines.

OUR UNDEVELOPED IRON ORES.

By J. J. O'CONNOR, Port Arthur.

Out there in the wilderness of Northern Minnesota, on the eastern Mesabi iron range, history is being made that will have its reflection for generations to come in the story and romance of iron ore on this continent. This history, and the practice that makes it, should excite the keenest interest on the part of Canadians, as it makes possible the practical utilization of low-grade iron formation, having an iron content between 20 and 30%, of which Canada has an abundance, averaging much higher in iron, and very similar in structure, which may be readily put to the same practical use.

Minnesota has a wealth of high-grade, cheaply mined iron ores, that are in such active demand as to tax the capacity of production on the various ranges of the State, for many years to come. This State is also the possessor of an enormous reserve of low-grade ores, running into a tonnage almost beyond computation, or, at least, to figures that are beyond the comprehension of the average mind. Until recent years, these ores were considered to have no merchantable value whatever. Now they are classed as the most valuable potential asset of the State, the utilization of which, will enable Minnesota to retain for generations the premier position she has won as the greatest producer of iron ore, on this, or any other continent.

The group of courageous and experienced iron-ore operators who, by scientific research and experiment, together with a large expenditure of money, have shown the way to make billions of tons of presently valueless iron formation, into a highly desirable and valuable commercial product, have conferred incalcuable benefits on industry, and have built for themselves an enduring monument in the iron-ore world.

Undaunted by the fact that they were alongside high-grade open pit-mines, that are operated at a minimum of cost for mining the ores they produce, these men set about the erection of a "pilot plant" at Duluth, Minn. and after two years of experimenting in the application of modern scientific methods, and the expenditure of $780,000, they have succeeded in producing from these low-grade ores a product that has met all the requirements of the most exacting furnace practice, and that can be put on the market in open competition with any of its rivals, at a cost that amply warrants the undertaking they are now engaged in at Babbitt, Minn. in the erection of a huge concentration plant. The first unit of this plant will cost $3,000,000, and will be in operation by June the 15th next. This unit is approximately 2500 feet long, by 66 feet wide, constructed of steel and concrete, on a general plan that calls for 22 similar units, when this plant is finally completed.

In addition to the concentrating plant, this enterprise includes the building up of a modern town, equipped with every facility for the accomodation of its officers and an army of workmen, together with their families, including a school and fully equipped recreation requirements, and the construction of several miles of railway for trackage purposes. (See page 35 of March issue for full account of this plant).

All of this is being carried out, practically within sight of the Canadian border, where uncounted millions of tons of similar ores are lying unused and untouched, for want of proper efforts being made to remedy this condition of stagnation. There are no doubts in the minds of men familiar with the concen-

tration of magnetites, that if sustained efforts of like kind, were put in operation on the Canadian side of the border, like results would follow, and all of the known large deposits contiguous to the Canadian National Railway, would be converted into hives of industry, that would go a long way toward solving Canada's railway problem, and assure her industrial independence.

In order that this may be brought about, it is necessary that a demonstration plant be put in operation at some suitable point, and the commercial feasibility of the process thoroughly demonstrated. If this were done, it is confidently believed there would be no difficulty in raising the necessary capital to carry out the enterprise on a sufficiently large scale to ensure its complete success. Any such undertaking must be based on the handling of very large tonnages. The plant must be equipped with heavy machinery, capable of standing the punishment of heavy and sustained loads for extended periods, therefore, it will require the investment of large capital to ensure adequate success, by furnishing a product at an economic cost, that will enable it to compete in the open market with the high-grade ores of the United States mines.

To enable this capital to be secured, the Federal government should undertake this preliminary demonstration work. The cost of such a demonstration would be small compared with the immediate benefits it would confer on the whole of Canada. The successful conclusion of such an experiment would seem to be guaranteed, in face of the results that have been obtained in Minnesota, on ores of a lower iron-content than our own. With these results in view, it does not seem possible that Canada's public men will sit down on the enormous ore deposits we possess, and do nothing, while we continue to import 95% of our ore requirements, while similar ores are being proftably used by our next door neighbours.

If the recent discussion in the House of Commons, on "natural resources," that took up the time of the sittings of a whole day, and resulted in—nothing, had brought forth a single practical policy, or the suggestion of one, for the economic use of our low-grade ores, it would have had an encouraging effect. This discussion cost the country more money, in the time spent by the House, than would be the cost of a competent committee of its members, to proceed to Minnesota and investigate for themselves what is being there, and what may be readily repeated on the Canadian side of the border.

Viewed from whatever standpoint, the outstanding importance of this question of the utilization of our low-grade iron ores, is second to none in Canada's welfare, and pressing financial needs of the present time. The benefits that would flow from the upbuilding of a great iron and steel industry in Canada, have been so often stressed by both writers and speakers, that, that phase of the question requires no further comment. What is wanted now, is action, continuous and intelligent action, until the goal of accomplishment is reached, that will place Canada in an independent industrial position.

Before the present session of Parliament is prorogued, a sum should be placed in the estimates sufficient to carry out the necessary experimental demonstration. In the face of a dying industry, it is the plain duty of Parliament to do so.

BRITISH EMPIRE STEEL CORPORATION, LTD.

A circular, identical in wording, has been issued to the shareholders of the Dominion Steel Corporation, Ltd., the Nova Scotia Steel & Coal Co., Ltd., and the Halifax Shipyards, Ltd., signed respectively and singly by the president of each company named, setting forth the terms of a consolidation of the finances and operations of the three enterprises and their subsidiaries, which the directorate of each company specifically recommends for approval and ratification of the shareholders.

Enclosed with the explanatory circular is a Balance Sheet consolidating the assets and liabilities of the three constituent enterprises as at December 31st, 1919. The result of the operations of 1920 are therefore not shown in this balance sheet, but the report of the Nova Scotia Steel & Coal Company for 1920 has already been issued, and its satisfactory character—in view of conditions during 1920—is generally admitted. The circular contains an assurance that the operations of the Dominion Steel Corporation resulted during 1920 in satisfactory earnings also, but as the fiscal year of this company does not close until 31st March, it was not considered practicable to project a balance sheet as at the end of the calendar year 1920 for the combined companies.

The basis of share exchange and capitalization has been widely published in the press, and it is not therefore necessary to include these details in this summary. There are, however, certain statements regarding the technical reasons for consolidation, that are quoted from the circular, as under:

"In June of last year you approved of an agreement under which the common shares of your company were to be exchanged for shares in British Empire Steel Corporation, Limited, organized under the laws of the Province of Nova Scotia, with an authorized capital of $500,000,000.

Owing to circumstances which have since arise, the directors of your Company have considered it inadvisable in your interests to have that agreement carried into effect, and the British Empire Steel Corporation, Limited, has agreed to a new arrangement in accordance with the terms of agreements, copies of which are enclosed herewith.

Your Directors are strongly convinced of the desirability of attaining the primary object of the original proposal, namely, the consolidation of the operations of your Company with those of the Nova Scotia Steel & Coal Company, Limited, and a new proposal having this principal end in view is now submitted to you involving the acquisition of shares of the following companies only:

Dominion Steel Corporation, Limited, and its subsidiaries, Dominion Iron & Steel Company, Limited, and Dominion Coal Company, Limited.

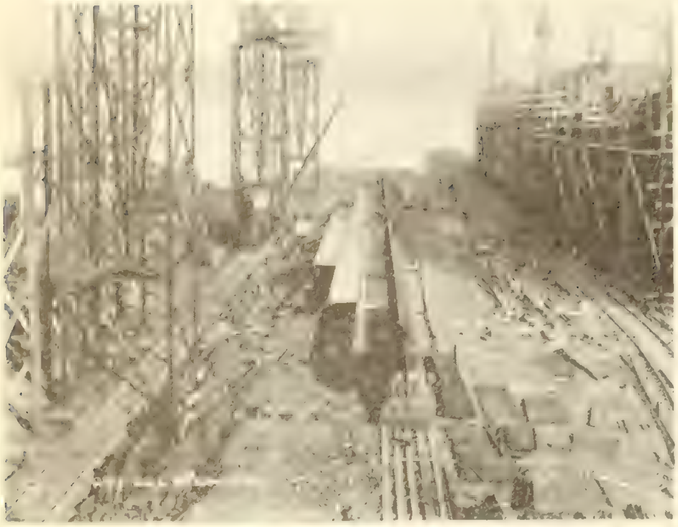
Nova Scotia Steel & Coal Company, Limited, and its subsidiary, the Eastern Car Company, Limited.

Halifax Shipyards, Limited.

on the basis herein set forth.

Your Directors consider the advantages of an alliance between the two senior and principal companies are so well known and appreciated that it is unnecessary to present them formally to the shareholders in this circular.

The inclusion of the Halifax Shipyards, Limited, another Nova Scotia enterprise, would appear to be a logical outcome of its situation on the Eastern At-



[illegible] Keel [illegible] October [illegible]
Halifax Shipyards.

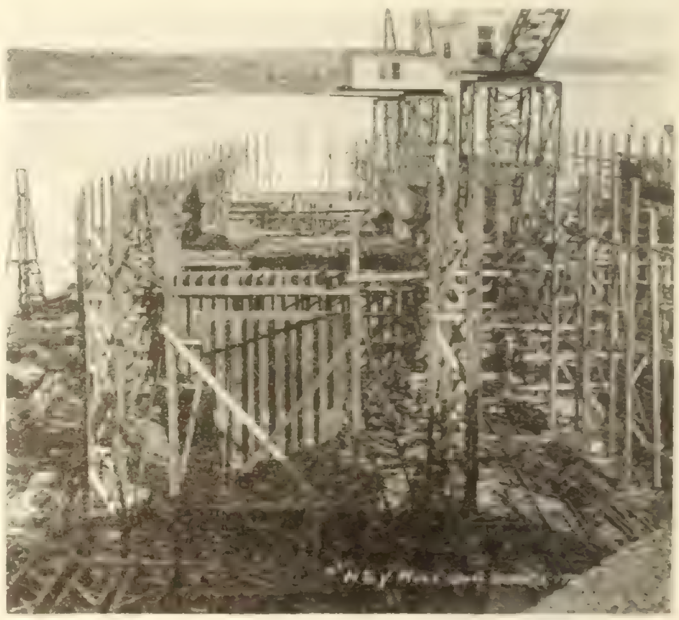
lantic seaboard, and will provide an important outlet for the products of the Dominion Corporation and the Scotia Company. Halifax is admirably situated as a relief port for vessels which become disabled on the North Atlantic. During the last two years, the Company's slipways at Dartmouth hauled out 895 vessels of all classes, and repairs were executed on 294 ships at Halifax Graving Docks. At present two 10,500-ton vessels are in course of construction. Extensive economies in the operation of all plants should be effected under one general management and control.

[illegible] at end of March, [illegible]. Launch expected in [illegible]

The British Empire Steel Corporation, Limited, has entered into covenants with the Dominion and Scotia Companies that it has no outstanding liabilities other than the expenses incurred in its organization and promotion, that it has no contracts or obligations outstanding other than those arising out of contracts or agreements for the exchange of shares with the three constituent companies, and that until it has acquired the common shares of the Dominion and Scotia Companies and 85 per cent of the issued common shares of Halifax Shipyards, Limited, and until its permanent board is appointed, it will not issue any of its capital stock other than may be necessary to effect the exchanges above referred to, and that it will not create any liabilities except such as may be reasonably incurred in completing its organization and the acquisition of the said shares.

The majority of the permanent Board of the British Empire Steel Corporation will be composed of members of the present Boards of the Dominion and Scotia Companies.

Mr. R. M. Wolvin, President and Director of and a shareholder in the Dominion Steel Corporation,



Progress on "Canadian Constructor" at end of March, 1921 Halifax Shipyards. Launch expected in Autumn of 1921.

Limited, is also a shareholder in the Nova Scotia Steel Steel & Coal Company, Limited. Mr. J. W. Norcross, Vice-President and Director of and a shareholder in Dominion Steel Corporation, Limited, is also a shareholder in Halifax Shipyards, Limited. Mr. H. B. Smith, a Director of and a shareholder in Dominion Steel Corporation, Limited, is also the President, a Director and a shareholder in Halifax Shipyards, Limited. Mr. J. F. M. Stewart, a Director and shareholder in Dominion Steel Corporation, Limited, is also a Director and a shareholder in Halifax Shipyards, Limited. Mr. D. H. McDougall, a Director of and a shareholder in Dominion Steel Corporation, Limited, is also the President, a Director of and a shareholder in Nova Scotia Steel & Coal Company, Limited.

Mr. W. D. Ross, Vice-President and a Director of the Scotia Company, is a shareholder in the Dom-

inion Company, and Hon. Lorne C. Webster, a Director of the Scotia Company, is a shareholder in the Dominion Company, and Hon. R. M. McGregor, a Director of the Scotia Company, is a shareholder in Halifax Shipyards, Limited.

An agreement between this Company and the British Empire Steel Corporation, Limited, has been concluded, and a copy is enclosed herewith. The agreement cannot become effective until it has been approved by a majority vote of the common shareholders present in person or by proxy at a special meeting called for its consideration, but upon such approval and upon approval by the shareholders of common shares of the Nova Scotia Steel & Coal Company, Limited, of a similar agreement between that Company and the British Empire Steel Corporation, Limited, for the acquisition of all the common shares of the Nova Scotia Steel & Coal Company, Limited, the common shares of both companies will, in accordance with the Act of the Legislature of Nova Scotia, Chapter 183 of 1920, become vested in the British Empire Steel Corporation, Limited."

The special meetings of shareholders called for approval and ratification are called at the head offices of the companies interested for April 7th, and it is presumed that these meetings will be of a purely formal nature.

The circular, it will be noticed, bases the desirability of consolidation upon the necessity to combine the operations of the Dominion and Scotia companies, and regards the inclusion of the Halifax Shipyards as being a logical outcome of the geographical situation of this shipyard and the complementary character of its steel shipbuilding and marine repair-work to the ship-plate mill and forging equipment of the two senior and principal companies. The emphasis in the recommendation of the directorates of these companies is therefore laid upon technical considerations and economies expected to result from undivided management, and in this point of view the directorates are justified in believing the advantages of alliance are well-known and appreciated by the shareholders and the general public.

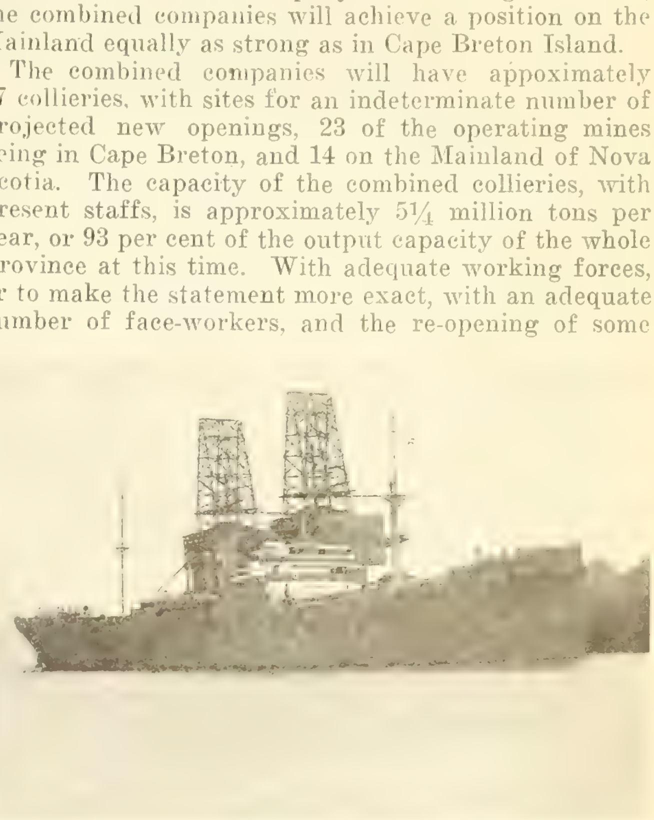
The Balance Sheet shows Current Assets, made up of cash, call loans, government bonds, accounts receivable and inventories of $34,376,000, against which are Current Liabilities of $13,675,598, leaving working capital of approximately $20,000,000. The financial statement is certified by the auditors as being prepared "after giving effect to certain appreciations in value of "fixed assets which are supported by certificate of the Canadian "Appraisal Company." The fixed assets, including land, buildings, plant and machinery, mining properties and equipment, after deducting $20,172,938 for depreciation reserves, are estimated at $130,783,668. The capital stock to be issued is $101,750,000, to which is to be added $31,102,475 for bonds and debenture stock composing the funded debt of the constituent companies. The surplus of assets over liabilities is estimated at $26,310,154.

A brief summary of the properties of the constituent companies may be attempted.

Coal Properties.

The Dominion Steel Corporation and the Nova Scotia Steel & Coal Company between them will control virtually all the coal areas in Nova Scotia, as yet discovered, where large-scale production of coal is profitably possible in a normal market. All the sea coal in the Sydney Coalfield, along the entire frontage of the productive Coal Measures from the Great Bras d'Or to the outcropping of the lower seams between Morien and Mira Bays will be controlled by a combination of the two companies. The Dominion Coal Company, through its acquisition of the properties of the North Atlantic Collieries at Morien Bay, the Cape Breton properties of the Cumberland Coal & Railway Company, and the areas under the Bridgeport Basin, has in recent years greatly enlarged and notably consolidated its strategical position. By control of the Springhill Collieries in Cumberland Co. by the Dominion Coal Company, and virtual ownership by the Scotia Company of the Acadia Coal Company's areas in Pictou Co., added to the coal properties already owned by the Nova Scotia Steel & Coal Company in that neighbourhood, the combined companies will achieve a position on the Mainland equally as strong as in Cape Breton Island.

The combined companies will have appoximately 37 collieries, with sites for an indeterminate number of projected new openings, 23 of the operating mines being in Cape Breton, and 14 on the Mainland of Nova Scotia. The capacity of the combined collieries, with present staffs, is approximately 5¼ million tons per year, or 93 per cent of the output capacity of the whole Province at this time. With adequate working forces, or to make the statement more exact, with an adequate number of face-workers, and the re-opening of some



"Canadian Explorer," constructed by Halifax Shipyards, taking coal at Nova Scotia Steel & Coal Coy's. loading towers at Halifax Terminals.

mines temporarily closed, the existing mine openings proposed to be consolidated would have an output capacity of about 6½ million tons annually, and the companies could be conservatively estimated to control 95 per cent of the possible maximum coal production of the Province under the most favouring conditions of demand.

Iron Ore Mines and Limestone Quarries.

Under combined management the entire iron-ore deposit of Wabana in its extreme land and seaward extensions would be controlled by the consolidation. This iron-ore deposit, which, under the laws of Newfoundland, the companies own in fee simple and not under leases, is without doubt the chief and most lasting asset of the merged companies.

In Edwin C. Eckel's recent work on "Coal, Iron and War" he gives a comparative table of the world's iron ore reserves with estimated duration at present rates of mining, from which the relative standing of the Wabana deposit may be gauged. The table referred to is as follows:

Region	Ore Reserve and Mill. of Tons	Annual Shipments Mill of Tons.	Duration. Years.
Brazil	7,500	..	..
Lorraine	5,600	40	140
Newfoundland	4,000	1	4,000
Cuba	3,000	2	1,500
Lake Superior, U.S.	2,500	55	45
Southern U.S.	2,000	6	333
Scandinavia	1,500	8	188
Great Britain	1,300	16	81
Spain	700	10	70
Northeastern U.S.	600	2	300

At no point in the extensive operations of the Dominion and Scotia Companies is consolidated management more desirable, or likely to result in greater economies and advances in production than at Wabana. While Mr. Eckel's mode of calculation gives Wabana the longest life of any known iron-ore deposit, it is quite unlikely that the very modest yield of a million tons annually, which has been the average annual output for the past decade from Wabana, will remain for long unimproved upon.

At Port-au-Port, on the West Coast of NewFoundland, the Dominion Steel Company has a limestone deposit of great depth, extent and purity, which assures an adequate supply of fluxes for many years to come. At Marble Mountain, on the Bras d'Or Lakes the Company has another limestone deposit of smaller extent than the one at Port-au-Port. The Nova Scotia Steel & Coal Co. has also a limestone quarry not far distant from North Sydney, and quite conveniently situated.

The Dominion Steel Company has extensive deposits of high-grade silica rock at Whycocmagh, Cape Breton, and has practically ready for operation a plant at Sydney for making silica bricks for use in the Steel Plant. Both Dominion and Scotia also own clay deposits suitable for ordinary brick manufacture.

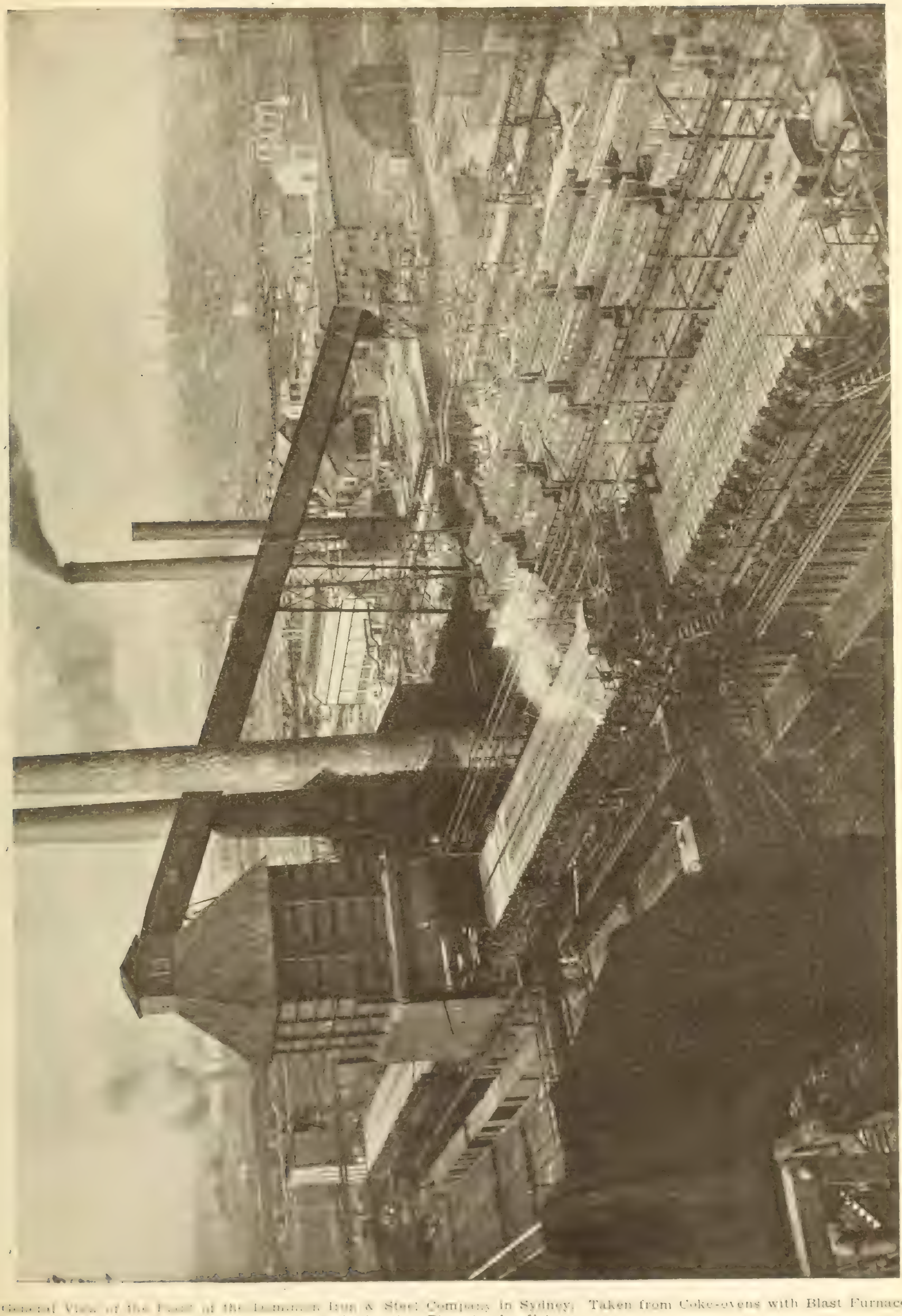
Lumber Properties.

The Nova Scotia Steel and Coal Company, by adding to its already large holdings of lumber lands in Nova Scotia, the areas of the Rood Macgregor Company of New Glasgow, has become one of the leading lumbering companies in the Province. The Dominion Company, by acquirement of the very extensive timber lands of the Cumberland Railway & Coal Co. in the Springhill and Parrsboro districts of Cumberland County, and by ownership of timber lands and sawmills in New Brunswick, is also an important holder of timber properties, and consolidation will result in a new alignment of timber holdings in Nova Scotia.

Steel Manufacture.

The plant at Sydney has in recent years received very important rehabilitation and additions. New coke-ovens, new washplant, and the new plate-mill have been described in "Iron & Steel" as having been added within the past four years. In addition the blast-furnaces have been extensively renewed and enlarged, the power-plant has been much enlarged and the plant gen-

New Pithead Arrangements at Jubilee Shaft, Nova Scotia Steel & Coal Co., Sydney Mines—now under construction. Steel and concrete fireproof structure to handle 2,000 tons coal daily.



General View of the Plant of the Dominion Iron & Steel Company in Sydney; Taken from Coke-ovens with Blast Furnaces and Shipping Piers in the distance.

erally speaking, is in better condition than at any time since its inception. Some further expenditures on the open-hearth plant and soaking-pit equipment are needed, but, it is quite proper to state that as a producing unit the Sydney plant was never in such good shape as it is at this time.

The smaller plant of the Nova Scotia Steel Company at Sydney Mines is also in excellent repair. The second blast-furnace is quite new, and the first blast-furnace is being held in readiness as a spare whenever it should become necessary to re-line the other furnace. The addition of new stoves would give Sydney Mines two complete blast-furnace units, should this policy ever be considered necessary. The policies that combined operation will make possible will doubtless have much bearing on the future of the plant at Sydney Mines.

Rolling and Finishing Mills.

The mills at the Sydney Plant include a blooming mill, steel-rail mill, plate mill, and a 16-inch mill used during the war for rolling shrapnel blanks, and now rolling small pitrails and other small sections. There is also a rod and bar mill, a wire mill, and a very large and well equipped nail mill, with galvanizing equipment and barbed-wire machines.

At New Glasgow, the Scotia Company has equipment for turning out the heaviest forgings, and has specialized in marine work. There is a small plate-mill, and the Company is especially well equipped to make small steel products, such as small rails, fishplates, and all kinds of rail fastenings, nuts, bolts and spikes, angles and bar steel and all varieties of machinery, car, spring and agricultural implement steel. Locomotive and freight car axles, marine shafting, rudder stocks and heavy marine forgings also form a staple part of the New Glasgow production.

The works of the Eastern Car Company, and the shipbuilding yards, are logical outgrowths of the New Glasgow plant, and are complementary thereto.

The position of the Scotia Company at New Glasgow has been much improved by its acquisition of a controlling interest in the Acadia Coal Company, which possesses a particularly well-designed power-plant at Stellarton from which current is available for the Trenton Works at pitmouth fuel costs. In this connection, it may be remarked that an electric furnace is being installed by the J. W. Cummings Co. at New Glasgow, and it would not be surprising if the Scotia Company were to take advantage of its ability to obtain moderately-priced electric current from its Stellarton collieries to install an electric furnace for re-melting ingot croppings and other locally furnished scrap.

Halifax Shipyards.

The plant of this Company has been described in "Iron & Steel" and on several occasions referred to. The chief asset of this Company is the site it owns on Halifax Harbour, a site that could not have been obtained but for the widespread destruction wrought by the Halifax Explosion. No matter whether steel shipbuilding survives in Canada or not, there will always be sufficient repair work at Halifax to keep a dry-dock and repair plant much more than fully employed, and, of course, Halifax is a growing maritime and naval centre. If steel shipbuilding does become a permanent industry in Canada, without first passing through a period of decline and idleness, Halifax will always be a

The Graving Dock, Halifax Shipyard, Ltd.

preferred port for such work, and the Halifax Shipyards has the preferred site in the Harbour. No one who has studied the progress of industrial nations can fail to see that someday, apart altogether from passing considerations, Halifax must become a centre of shipbuilding, as well as a repair port.

The Nova Scotia Steel & Coal Company's New Glasgow plant is only a half-day's railway journey from Halifax, and it has been the custom for many years to obtain repair parts and forgings from New Glasgow, at short notice, for ships entering Halifax for dry-docking and repairs.

Loading and Discharging Plants.

The Dominion Coal Company has discharging towers, barges and elevator barges at Halifax, St. John, N.B., Quebec and Montreal. The Scotia Company has unloading towers at Halifax, Quebec and Montreal. The Dominion Company has extensive warehousing accommodation and stocking grounds in Montreal. Both companies are large shipowners and charterers, and they have much marine equipment in the shape of tugs, salvage-pumps and equipment, and have staffs with large experience in freighting business.

In addition, the Dominion Company owns and operates the Sydney & Louisburg Railway in Cape Breton, and the Springhill and Parrsboro road of the Cumberland Railway Company, both roads carrying considerable freight and passengers in addition to the coal and steel freights of the Company. The Nova Scotia Steel & Coal Company also operates a large aggregate trackage of branch colliery roads.

Should the British Empire Steel Corporation now become a reality, as it seems probable it will, some approximate figures of the extent of the enterprise may be of interest.

The employees should number about 25,000, including the collieries, iron-ore mines and limestone quarries, steel plants, shipyards, car-works, lumbermen, ship employees, longshoremen, etc. Coal output should reach six million tons annually, and production of steel ingots 500,000 tons per year. The requirements of the steel companies has not hitherto required more than from one million to a million and a quarter tons of iron-ore, but the present capacity of the ore mines would enable this quantity to be greatly exceeded if export business could be secured to enable the mines to work all the year round, which up to now, they have only very rarely attempted to do.

IN THE DAYS BEFORE THE WAR.

[illegible] 1908. On the date selected, taken at random, the Dominion Coal Company's fleet totalled 87,000 tons, including 19,000 tons ship- [illegible]

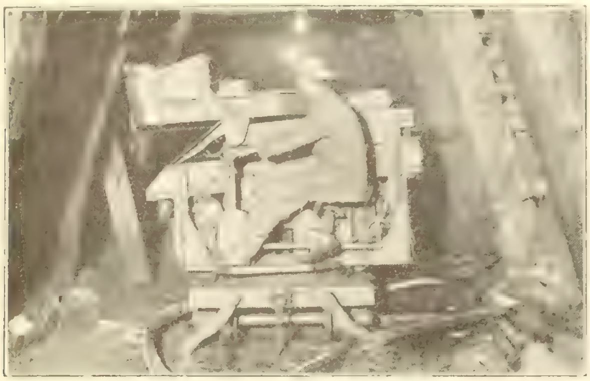
The Hoar Underground Shovel

A Successful Mechanical Loader, Much Used in the Michigan Copper Mines, to be Manufactured in Canada.

The substitution of mechanical devices for loading mined material underground has during the war period made much progress in the United States and in Newfoundland. In the Michigan copper mines a number of devices have been evolved to suit local conditions, a brief account of which was given in our issue of February 6th last, and at the ore mines at Wabana in Newfoundland, the use of mechanical loaders has virtually superseded manual loading.

One of the loading devices that has found much favour in the Michigan mines is the Hoar Shovel, the invention of a Cornish mine captain long resident in the United States. The Port Arthur Shipbuilding Company is now building one of these shovels for the Canadian Mine Shovel Company, of Toronto, which is introducing the device into Canada. We have received some particulars of the Hoar Shovel that may be of interest to our readers.

The Hoar loader has four principal parts, namely, the truck, the body, the table, and the dipper and



The Hoar Shovel in position for transport.

dipper sticks. The truck is a substantial steel frame on which are mounted the swinging gear, truck bearings, wheels and rail clamps. The body of the machine is a structural-steel frame to which is rigidly fastened the power unit and which also supports the parallel steel tracks in which the table rollers run. The table is a cast-steel frame mounted on six hardened-steel rollers. It carries the bearings for the double dipper-stick. The dipper mechanism consists of two arms pivoted together so as to allow the dipper a range of flexibility in working the bottom.

The engines used are reversible air-motors, only three levers being used. They are double reciprocating —or in one sense, slide-valve double engines in exceedingly compact form. Two pistons operate, one inside of the other, and transmit a rotary motion to the engine shaft. When the pistons are placed in position in the cylinder, a hole or bearing at the center of the inner piston fits over the pin of the crank on the engine shaft. The outer piston has a lateral reciprocating movement: the inner piston has an up-an-down reciprocating movement. These movements are so arranged and timed that both pistons are always working in unison. The pistons take air through the two circular ports in the cover which have a cored-out connection to the throttle.

All running parts are renewable and all working parts are of wrought-iron, steel or brass. All parts subject to shock, such as table, truck, dipper-arm and rollers are of steel. Truck and body frames and dipper sticks are of structural steel. The wearing parts of the dipper are of special-composition, hard steel.

The shovel swings on double steel-ball bearings. High-grade bronze bearings on the axles add to the ease by which it can be pushed by hand.

All other machine bearings subject to heavy wear are bronze bushed and easily renewable. The hoisting rope is 2 x ¼ inch flat wire-rope tested to a four-ton working load. It is easily removed for replacement.

The Hoar Shovel is primarily designed for underground use. It works nicely in a 7 ft. by 7 ft. drift, but for open pit work, where the large-size steam shovels are not applicable and hand shovelling is necessary, it is excellently adapted, and is a great saving as compared with hand labour. The shovel works with compressed air, using about 300 cubic feet of free air per minute. It can be made to operate with steam, with very little change.

The Hoar Shovel at work.

The machine is mounted on a truck, which, in turn, is mounted on eight-inch wheels in front, and twelve-inch wheels at the rear, to give clearance over a high car. The body of the shovel is swung in either direction through a complete circle on double ball-bearings by a reversible air-motor. A second reversible engine, through a self-locking worm gear, drives the table, on which the dipper stick is mounted, forward and backward, giving direct thrust into the breast, as well as the extension needed for dumping and trimming beyond the centre of the dirt car.

As previously stated, the Port Arthur Shipbuilding Company is constructing the Hoar shovel for Canadian sale, and is now working on a first order of six shovels. In Canada, the Canadian Mine Shovel Company of 202 Lumsden Building, Toronto, will handle the rights of manufacture and sale. The shovels are being made in the United States by the National Iron Company of Duluth, and the patents are owned by the Hoar Shovel Agency, Inc. at Virginia, Minn.

The Hoar shovel is said to be well adapted for work in restricted spaces. Two men, according to the statement of a mining company that is using the shovel, can load sixty tons in a eight-hour shift.

DROP FORGINGS.

The Criticism of Billets.

Neither drop stampers nor steelmakers wish for failure, and the natural instinct of each of them, when failure occurs, is to blame the work of the other. In the process of stamping and pressing very abnormal strains may be produced if dies are unsuitably designed or if the material is unsuitably worked, and these strains may be more than can be borne without failure by even the best steel. The qualities of steel, moreover, vary, and the selection of the right steel for a particular job may sometimes be more difficult to the stamper than the manufacture of the steel is to the steelmaker. If steel fails through unsuitable dies or working, or the wrong choice of the steel for the job, the fault does not seem to lie with the steelmaker, On the other hand, if the failure is due to some fault in the billet, the stamper is not to blame. It may be of interest to indicate some considerations that may arise in the criticism of billets for the use of stampers, which means in effect billets that are as nearly faultless as they can be.

Cracks in Ingots.

First and last, what is most wanted of a forging is that it shall not break; and the most obvious cause of breakage is that the forging is cracked. A crack may be started at any time, and some cracks occur in the original ingot itself. The main cause of such cracks is that the ingot was cast at too high a temperature. When steel is cast at a temperature somewhere near its melting or freezing point the outer face of the ingot sets immediately on contact with the sides of the ingot mould, and forms quite small chill crystals, on which set subsequently the free crystals composing the body of the ingot. If, however, the steel is substantially above its freezing point the chill crystals are larger and coarser, and extend some way into the body of the ingot. The structure so formed of large chill crystals is mechanically much weaker than when the crystals are small, and assuming the ingot mould to be square, as it usually is when mechanically strong material is required, the ingot will consist roughly of four triangular prisms, resting on the faces of a four-sided pyramid which forms the base of the ingot. As the ingot cools the faces of these four geometrical figures tend to pull apart from each other, and internal cracks are readily formed between them, sometimes running into hundreds. Even if they do not occur in the first complete setting of the ingot, the strains and the weakness will nevertheless be present, and cracks may be produced when in the course of working additional strains are set up by heating or by cooling, or by any external cause such even as rough handling. Thus in such ingots rolling or heavy forging usually sets up deep-seated cracks, which run across the thickness of the ingot, and as the rolled ingot gets longer and longer the transverse crack is developed longitudinally, and on the billet is seen as a seam or roak.

The primary crystalline arrangement of chill and free crystals is never entirely destroyed by rolling or forging. Thus a section through a web of a machined aero crankshaft forging may be seen on etching to show chill and free crystals with much the same distinctness as the original ingot. Billets, therefore, that are made from ingots with coarse chill crystals will as a rule have cracks, roaks, or seams that accompany them through life and appear as a source of weakness in any forging produced from them. For such defects and their consequences the stamper can certainly not be held responsible. The difficulty is of course to be sure whether the defect does in fact date back to the ingot.

Blowholes, Pipes, and Segregates.

Blowholes are formed when gas or vapour is trapped within the freezing metal of the ingot. They may be caused in a variety of ways. The worst blown ingots are of steel in which the gas-forming reactions of the furnace are still incomplete when the ingot is poured, and go on until it freezes and the gas bubbles are trapped. On a less wholesale scale they may arise from the decomposition of dirt (usually oxide), which may occur on or near the surface of the ingot, and the gases may be trapped there or be carried inwards and upwards, bearing with them particles of impurities with a lower freezing point than the mass of the metal, which line or fill the cavities in which the gas is ultimately trapped. The oxide may be derived from the surface of the mould. In top cast ingots it may also be formed by oxidation of the thin shallow shell of metal that sets against the sides of the mould when the energy of the stream falling from the ladle swirls the top of the molton metal in the ingot a little above the level of the ingot surface. When this happens the shell oxidizes as soon as it forms, and the fluid metal thus rises inside an oxidized envelope, which by reaction with the carbon of the steel continuously evolves gas, of which some gets trapped and forms blowholes.

Though blowholes do not as such give rise to cracks, they are obviously a source of weakness, only to be tolerated if they occur where they do not matter or if they weld up in working. For most drop stampings it is only on the latter assumption that blowholes can be tolerated in ingots from which billets are made. How far that assumption has been verified in practice is at present a moot point. There is certainly a good deal of evidence to suggest that perfect welding does not occur, even in a clean blowhole, and it is obviously impossible in one that is lined or filled with segregates; moreover, the latter types of blowholes or of segregation form what in machining are hard spots, and are resented by the stamper's customers. The segregates may also be rolled into the substance of the billet below the skin, and become possible sources of seams or even cracks unless the billet is rough turned. Pipes, which arise through the shrinkage of the metal on cooling and solidifying, are open to much the same criticism as blowholes, except that they are exposed to oxidation by the atmosphere, and therefore even less likely than blowholes to weld up in working, while the segregate lining that is usually found within pipes is, of course, unweldable. Pipes can be avoided by allowing the formation of a sufficient volume of blowholes, or, by adopting suitable shape of mould and casting arrangements, may be located where they do little or no harm or can be economically discarded.

Reheating and Forging.

The strength of a stamping, as determined by its structure, is affected also by the processes of reheating and forging to which the ingot is subjected in making the billet and the billet in making the stamping.

The changes to which these processes give rise are well defined by microscopic examination. Up to visible redness nothing happens, but at a definite higher

temperature (about [illegible] C. for 0.3 carbon steel) the constituents of the pearlite begin to interdiffuse, and this process continues till at another definite temperature (about 850deg. C. for 0.3 carbon steel) the interdiffusion is complete and the large crystals of the ingot or billet have been replaced more or less completely by crystals hundreds or thousands of times smaller. So long as the temperature does not rise higher the size of the crystals does not increase, and if the material could be worked at that temperature the troubles due to reheating would be unknown.

Unfortunately economical working requires the material to be hotter, and with a rise say of 50deg. C. the crystals begin to grow larger, and the growth continues till the temperature, say 1,100 deg. C., at which the billet is withdrawn and stamped. The increase in size of crystals has weakened the material as compared with what it was at say 800deg. C., but this relative weakening is a defect less conspicuous in the subsequent working than what happens if the billet is heated still higher, up to say 1,200deg. or 1,300deg. C. At these temperatures the metal is commonly said to be burnt, but what has really occurred is that the crystals have not really continued to grow larger, but have begun to melt round their peripheries. The consequence is that if the material, when worked, does not go to pieces, it will contain small holes in its interior, and though outside the billet may look all right, the internal defects are likely to produce failure when it is worked.

These troubles are accordingly due not to the quality of the steel or the method of manufacture of the billet, but to its treatment after it has left the steelworks. The extent to which they may go depends on the toughness of the steel. The strains to which billets are exposed in working are not merely those impressed on it mechanically. Steel, for instance, when heated expands up to about 750deg. C., and then suddenly contracts. Now under works conditions a billet is not heated so slowly that its temperature rises uniformly throughout its mass, and the difference between outside and inside temperatures may be 50deg., or even 100deg. C. Thus, as each part of the steel reaches about 750deg. C. one part will be still expanding while another part not far removed suddenly contracts, and the intermediate part is subjected to a strain which, if it is too severe or the metal is too hard or too little tough, may result in a clink, or firecrack, which opens out on rolling. In cooling, again, air-hardening steels are similarly subjected to strains due to unequal contraction through one side cooling more rapidly than the other, and cracks result. This defect appears most strongly when stampings are cooled, because both in and out of the dies the thick and thin parts cool at unequal rates, and the stamping also is less able than the billet to resist the consequent strains because of its relatively complex shape.

Some Conclusions.

If the drop stampers consider circumstances in the life history of the ingot such as those described above, they will see that, on the one hand, it, or the billet derived from it, may be delivered to them with latent defects, some visible and some undetectable by any practicable examination, which may, or must, lead to failure of stampings. They will see equally that, from the simple process of reheating the billet before beginning the work on it down to the complex shaping [illegible] the drop-stamper's treatment may introduce flaws into the most perfect of billets, and these may lead to wasted or dangerous stampings, Such failures are bad for both steelmaker and stamper; and although for the adjustment of an individual transaction the most important consideration may be to decide where the blame for the failure lies, the consequences of the failure are in the long run divided equally between the parties.

Hitherto, perhaps, the attention both of steelmaker and of stamper has been directed more to fixing the blame on the other party than to finding how the cooperation of both parties can serve to prevent future failure. Perhaps the most important consequence of the examination of a billet's life history is to show that such cooperation is as necessary for apportioning blame as for avoiding failure. Both the maker and the stamper have it in their power to affect profoundly the physical qualities of the billet and of the stampings into which it is made. The most effective result cannot be obtained if each does not appreciate as far as possible the difficulties of the other, and do his best to cooperate with the other in avoiding or overcoming them. The attitude may involve on each side some sacrifice of the immediate interest in criticizing an individual delivery. But the sacrifice will be repaid manifold by the increased ability of the combination of the two parties to secure the increased applications of drop stampings that most competent engineers regard as ultimately desirable—"Times" Engineering Supplement, March 1921.

REFRACTORIES IN MOULDING PRACTICE.*

By Mr. H. WINTERTON.

This paper is not intended to be an academic discussion on the various uses of refractories, but on a subject which, though formerly accounted as of but little worth, of late years has slowly but surely presented itself to foundrymen generally as a matter deserving no little thought and quite a considerable amount of care.

The lecturer briefly considered the meaning of the title of the paper. He thought Dr. Stansbie, in his thorough practical work, "Iron and Steel," defined the subject quite aptly and very clearly. This definition states that "refractory materials used for metallurgical purposes may be defined as bodies that can be exposed to the furnace temperatures for which they are used without softening or disintegration." This sums up in a sentence the whole secret of foundry refractories.

Generally speaking, foundry refractories may be divided into three classes, viz., acid, basic and neutral. The first-named are usually of service in steel foundries and the two latter in iron foundries. Included in the former are various silicates, whilst in the basic section are magnesite, bauxite, and other materials of a like nature, some of them far too expensive to be thought of in connection with castings for one moment. Graphite should be considered a neutral refractory, as it is neither basic nor acid.

Before leaving the general question of refractories one point was referred to which is not always recognised by foundrymen. It has reference to the siliceous

* Paper read before the Birmingham Branch of the Institution of British Foundrymen.

refractories, of which large quantities are in use. Practical men have sometimes found that acid-forming oxides, when heated and in contact with basic oxides, unite with them to form salts, usually silicates, which, though in some proportions more fusible than the silica itself, yet on being mixed in other proportions have their fusing point raised, and are thus at once rendered of a higher commercial value for the purposes under consideration. These exact proportions are not discovered without much patience and experiment, and even then the end of the task is not reached, for varying castings of different densities require special treatment in their manufacture.

These remarks respecting silica refer principally to steel-foundry practice, but not a few iron-founders occasionally make use of acid refractories when confronted with a huge mould which has to be cast at a great heat. The practice is, however, not general, and, so far as the author has been able to ascertain from careful inquiry, is not very likely to be much adopted. Possibly, one reason for this is the ever-varying proportions of the silicates upon which founders have to rely. Undoubtedly the steel moulder is very conservative, but he is no more than ordinarily averse to change when shown that by some comparatively new method he can increase his output and at the same time improve his work. He is perhaps impelled to use more than ordinary caution by the very nature of his task. An example is shown by the position of affairs when war broke out in 1914. For many years a large number of steel foundries had obtained their sand from Belgium, and at first it was thought no efficient substitute could be found. Close research, however, was carried out on British silica formations, and it is interesting to note that not only was the British product found to do the work as well as its foreign competitor, but that it could be produced cheaper. At present many firms have signified their intention to carry on with the home product. The steel moulder cannot give too much attention to the all-important question of refractories, as his work is carried out at a much higher temperature than that of the iron founder.

Ordinarily, the question of the refractories of sands used in iron foundries is not sufficiently considered. In the past it has been customary for one of the youngest boys to be entrusted with the task of daily producing enough sand for the work of his mate, neglecting entirely the nature of the job. The porosity of the sand, its properties in relation to silica, oxides, or alumina were phases of the question which never troubled the lad, and the resultant day's output must necessarily have been disappointing.

The connection between the refractories and the mounding sand is easily traceable. Coal-dust is used because if the sand were unsupported the molten metal would fuse the surface, resulting in a rough blemished casting. This fusing is caused by the alumina and oxides necessarily present in the sand as binding agents. The oxidation of the coal-dust causes the presence of carbonic oxide or carbon dioxide gas, and this provides the necessary protection when the metal is in a molten condition. Not only, therefore, is it necessary that care should be taken in the selection of the sand used in the foundry, but it is equally essential that the supply of coal-dust should be carefully watched. The porosity of the sand and the weight of the finished casting are important factors for determining its purpose, whether for suitable machining or not, which should also be considered by the foundryman. In selecting coal-dust for use in the foundry care must be taken to inquire into its bituminous qualities, its ash and volatile contents, and its proportion of fixed carbon. It is not intended to lay down a fixed rule with regard to these various constituents and their proportions, for experience has taught that few men think alike on this subject. Obviously too great a proportion of ash is most deleterious, and can only result in castings having a whitey-grey appearance, with a particularly rough surface, and probably sand-burnt. On the other hand, if a coal of too high a carbon content be used, with a necessarily low ash percentage, the facing becomes of too refractory a nature, and the coal-dust is unable to carry out the functions for which its application was intended.

Another matter of importance is the "grist" of the coal-dust. If it is important to control the porosity of the sand, surely it is equally important to consider the "grist" which the men have been accustomed to use for different tasks. It is necessary to vary the "grist" according to the class of casting required, and of the grade of sand used. This is a feature which is not always accorded the attention it deserves. For very light castings a coal-dust of an exceedingly fine mesh is desirable: especially if the sand is "open," whilst a slightly coarser, yet still fine, "grist" should be used for heavier work. The medium and coarse grades will be required for the large classes of castings, in which it is necessary for the generated gases to be carried away quickly. The provision of a skin to the casting is left to a large extent to the blackings, which are referred to in the next section.

Superfine coal-dust is essential for light castings; this has been proved by many successful experiments. On account of the lightness of metal, the gases have not been overwhelming, and the comparatively low temperature of the light body or iron has been sufficient to fuse the minute coal particles, and thus give a fine surface accompanied by easy stripping.

When coal-dust of too coarse a grade is used, small "pit" are left on the face of the casting when cooled. and these are easily distinguishable by their formation from those indentation caused by particles of sand insufficiently milled. Gas in excessive quantities—excessive in consequence of the size of the particles—takes the line of least resistance, viz., the soft molten metal, resulting in "pitting," which is too frequently seen in the finished article. Where larger castings are concerned, the heavier weight of metal, and the consequent increase in temperature, prevents such indentations, particularly as the coatings of blacking on big moulds are generally more pronounced.

After stating that there are several good designs of British sand mixing machines on the market, the author stated that few will be found to do the work better than a "hefty" laborer with a shovel and the knowledge of how to make the use of it effective.

Undoubtedly there is a wide divergence of opinion as to the uses of blacking, whether for loam, dry sand, green sand, or cores. Blackings or facings may be divided into various classes sand sections. The old fashioned idea of blacking moulds with all types of compounds, many of them of doubtful efficiency; some are most evil smelling, and not a few positively deleterious to the casting. A recommendation in a treatise

on foundry practice is to mix coal-dust as a facing. The adoption of this advice will undoubtedly result in surface trouble. The modern foundry demands various facings suitable for the particular class of casting upon which it is engaged, consideration being given to the thickness of metal, the heat of the molten iron, and the general characteristics of the finished castings. Hence, it has been established that for light castings nothing exceeds in efficiency a charcoal blacking of good quality though expert practical men are not quite in agreement as to whether a pure wood charcoal or one slightly stiffened with a mineral admixture produces the better results. Two light casting foundries, however, have mixed a special facing to their own formula, and even these differ to a marked degree in essential particulars. It is certain that both these foundries enjoy a high reputation for the excellence of their castings, whilst the proprietor of one asserts that since introducing the new method he had experienced far less trouble in the fettling shop and had effected a considerable economy in that department. For ordinary green-sand work which requires "sleeking," there are now prepared many mineral blackings which assist to bring out on the casting a blue glossy skin, so much sought after by founders. The true functions of facings are reflected by this very anxiety of the founder. He knows that given a good highly refractory substance the pores on the face of the casting will be closed up, and therefore the utility of the skin does not end with the colour. He knows, too, with a blacking of the right character the fettling of the casting is a matter of comparative simplicity. This remark applies not only to green sand but also to loam dry sand, and core work. It is necessary to have a stronger or heavier facing for the larger castings, because not only has the weight to be considered but the casting temperature in large moulds becomes a serious factor. Hence, it is necessary to provide a strong refractory in which the percentage of carbon grows higher in accordance with the strain sought to be put upon it. It is here that theory does not apply, but, where it does research becomes necessary.

From the previous remarks it might be understood that to get good results consistently it would only be necessary to raise the carbon content. But this is not all that is required. Some refractories are of so harsh a character as to preclude all thought of "sleeking" on a green-sand mould or mixing with water or clay wash in a boss, especially when newly prepared. It is here that the skill of the blender is required, and by his agency various facings are produced which can be held to cover all classes of moulds.

In many instances it has been found that the slightest modification of mixtures have made all the difference between a good-looking casting and an indifferent one. Trouble will result if a facing does not possess refractory characteristics to a high degree, when facing a mould of considerable size, which is to be cast at a high temperature. On the other hand, the presence in the blacking of too great a proportion of siliceous matter would cause excessive scabbing and burning. But as previously indicated, the use of a high refractory for light castings is not usually advisable. For cores a sound refractory must be used, but the necessity of providing something that will not easily rub off after baking must be kept clearly in view. Here again the task has been to provide an article which will perform its work perfectly under varying circumstances.

Graphic facings may be divided into three classes —plumbago, graphite, and blacklead. There are every many qualities, but it is more or less again a matter of carbon content, and founders who are satisfied with the commoner kinds must not expect to obtain such good results as others who endeavour to procure the highest grades. Here once more the question of individual practical test comes to the front.

During the war many founders discovered to what large extent we were dependent upon overseas possessions for the provision of some of the grades of plumbago. Several cargoes on the way to this country from Ceylon were intercepted by German submarines and sunk. As a result of war shortage the shipowner discovered the utility of the article which he had been previously carrying at a low rate, and as a result the freightage on plumbago has risen more than on the majority of commodities. Obviously a return to prewar costs in the matter of refractory compositions, incorporating plumbago, must necessarily be impossible.

The International Union of Iron Steel & Tin Workers is expected to hold its annual meeting in Hamilton May 2nd., and lasting three weeks. About 500 delegates are expected to attend from various centres of the United States and Canada.

How the Algoma Steel Company inculcates the spirit of emulation in Accident Prevention. Bulletin Board photo, reproduced from the "Algoma".

VICKERS LAUNCH S. S. "IDEFJORD" AT MONTREAL.

On the afternoon of the 9th April, the S. S. "Idefjord" was launched at the Maisonneuve Yards of Canadian Vickers Ld. The date sets an early record for launchings in Montreal yards. The "Idefjord" is one of two steel cargo vessels being constructed to the order of the Norwegian-American Steamship Company of Christiania, and the launching was performed by Mrs. Magnus Swenson, the wife of President of the Company in New York.

The sister ship of the "Idefjord" is expected to be launched in about three weeks time, and Mr. P. L. Miller, the General Manager of Caandian Vickers, Ltd., stated that his Company had no further orders in prospect, and that repairs would then constitute the only available source of employment for the Company's workmen. Reduction in employment would be necessary, and he was afraid that shipbuilding would not revive for at least a year. The Company were willing to accept smaller profits in order to meet the conditions, and it would be necessary for workmen to take smaller wages. Half a loaf was better than no bread, and reduction in the cost of shipbuilding was necessary if orders were to be obtained against outside competition.

PUDDLED IRON.

A process for the manufacture of puddled iron, covered by patents taken out by Mr. J. E. Fletcher, of Dudley, and Mr A. Jackson, of Low Moor, depends essentially on the production of a synthetic refined iron which is puddled in the ordinary way for the production of a high-grade wrought iron. This metal, made in the cupola from a mixture of pig iron and steel scrap in definite proportions and having a definite chemical composition, is stated to be almost identical with iron produced by the costly methods of "washing" or breaking down the impurities associated with crude pig iron, and to contain only 3 per cent. of impurities, as against 8 to 10 per cent. in crude pig iron. As compared with existing methods the process is claimed to reduce the cost and improve the quality of finished iron, to halve the fuel consumption, and to double the output of the puddling furnace, a 5 cwt. charge being worked in 40 minutes, so that an output of 50 cwt. of puddled iron becomes possible in an eight-hour shift.

ORNAMENTAL IRON WORK IN TORONTO.

The W. S. Mahaffy Company, Gladstone and Trafalgar avenues, Toronto, announce that they are operating a new department known as the Ornamental Iron Products Company. This department is under the management of J. Harlander, former superintendent of the Canada Foundry Company, and for twelve years with the firm of Jno. Williams, Inc., New York, in charge of the production of some of their finest examples of iron and bronze art work. The new department is now prepared to submit tenders on and execute all kinds of ornamental iron and bronze work.

The Temiskaming & Northern Ontario Railway Commission announces that it proposes extension of its repair shops estimated to cost $80,000, and will purchase new equipment to the extent of $57,000.

EDITORIAL

MODERATE-TEMPERATURE GASEOUS REDUCTION OF MAGNETITE CONCENTRATES.

In this issue will be found a description, by Mr. Noel Statham, of New York, of the Bourcoud open-cycle direct-process of iron-ore reduction through exposure to reducing gases at moderate temperatures, which has been especially prepared for "Iron & Steel of Canada" and will be of interest to our readers as it is written from the viewpoint of Canadian producers of iron and steel and miners of iron-ore in Canada. The article is especially timely as iron-ore mining in Canada has entirely ceased, a condition that is not previously recorded in the statistics of the Dominion since they were first compiled. The calculations included in the article are of especial value, inasmuch as they endeavour to take into account the fuel insufficiency of those portions of Canada where our iron-ore deposits are most numerous and accessible. In considering our native iron-ore resources it should always be remembered that accessibility is a major and deciding consideration from the industrial viewpoint. It is decidedly unfortunate that some of the iron-ore deposits of Canada that are reputed to be of largest extent and suitability are situated at points of great remoteness from centres of population and transportation lines.

The theoretical correctness of the method described by Mr. Statham would appear to be evidenced by that fact that a number of investigators are working independently to perfect processes that appear to be based on one principle.

As is pointed out in the article, the technical difficulties hitherto experienced in evolving a commercially successful process have originated in mechanical problems rather than in the reasoning connected with chemical reactions.

The Honorary Advisory Council for Industrial & Scientific Research has quite recently announced its belief that substantial progress has been made in a direction not dissimilar to the line taken by Mr. Bourcoud, and Mr. Statham mentions the leading part that has been taken in this work by Dr. A. Stansfield, the distinguished professor of metallurgy at McGill University, and the first editor of this periodical. The similarity of the Bourcoud process to that of Mr. J. E. Moffatt of Toronto, described in our issue of October 1920, will also be noted.

The success of any process based on the general principle referred to would appear to depend upon the degree in which the mechanical difficulties can be overcome, and upon the extent to which full and economical use of the reducing gases and their heat can be obtained.

The plan submitted to the Brazilian Government for smelting of the Minas Geraes ores is interesting to Canadian readers inasmuch as a well-known Canadian steel company for some years held an option on iron-ore deposits in this district. In Canada, no less than in Brazil, the utilization of low-grade fuels is a matter of the greatest importance. The part played by the gas-producer in the Bourcoud process is suggestive of a good many possibilities in Canada, as it is quite certain that the gas producer, generally speaking, has many undeveloped uses in this country.

THE MOOTED STEEL INDUSTRY IN BRITISH COLUMBIA.

"Mining & Engineering Record" of Vancouver, B.C., criticises the plans of the Coast Range Steel Company as being more ambitious than the prospective market for iron and steel products on the Coast warrants, and as being pressed at an unpropitious time. There are quite evidently some very erroneous ideas abroad in British Columbia, as for example a statement widely made through the newspapers that there is a market on the Pacific Coast (which presumably includes the United States) for 10,000 tons of steel a day, and that the same area consumes annually 4,000,000 tons of steel and iron. We would very much doubt the accuracy of such figures. Much is also being made of the requirements of the Pacific Coast in shipplates. With a large modern ship-plate mill idle at Sydney, even the continental stretch that intervenes does not warrant a new ship-plate mill in the Canadian West, and the least-informed student of affairs should know the condition of the steel shipbuilding industry is not roseate at this time.

Mr. E. A. Haggen, the Editor of the Vancouver paper referred to, remarks, and we desire to endorse his statement, that "there is no enterprise in which undue haste, improper considerations, misrepresentation and dealings with irresponsible interests will be attended with more disastrous effects than an iron and steel industry."

In a review of various proposals for the inception of a steel industry in British Columbia by Mr. Haggen, reproduced in this number, it is intimated that a proposal to establish a blast-furnace plant at Union Bay on Vancouver Island in co-operation with the Canadian Col-

Range Ltd. has fallen through, and that the projected site for a plant proposed by English interests unconnected with the Coast Range Steel Company's proposals is near the City of Vancouver. Such a site will require the bringing of both the coal and the ore from a distance, and, as compared with the Vancouver Island location will only have one advantage, namely that of nearness to an artisan population and housing accommodation. It is to be doubted whether this advantage will offset the admitted desirability of utilising all the heat units in coal consumed in metallurgical processes as near the pitmouth as possible, and in conjunction with associated colliery operations.

The proposal of the English interests, as outlined in the article referred to, is to create an assembling point for coal, iron and fluxes, which will be purchased from private miners. This is an arrangement that reverses the traditional policy of iron and steel companies, and, while it of course avoids the necessity of expending capital in unproven coal and ore properties, it carries with it much uncertainty in the matter of continuity of supply and purchase prices.

If it were possible for the iron and steel industry of the future British Columbia to develop by the expansion of existing mineral-mining enterprises in that province, commencing on a moderate scale commensurate with the insistency and extent of local demand for iron and steel products, it would be a development of a more logical character, possessing more inherent elements of permanence, than can be the case where new capital is projected into an untried field by persons new to the business and technical problems of the Coast.

A careful study of the history of the steel industry of eastern Canada is earnestly recommended to those who are working to create a similar industry in the West.

In our issue of December 1919, the lessons deduced from the evolution of steel manufacture in the East and their applicability to the mooted commencement of steel manufacture in the West, were attempted to be set forth, and as later happenings have served to confirm these lessons, their partial repetition may be permtted. From the experiences of steel-works management in the East, it is suggested the following conditions should be avoided, namely :

a. An unnecessarily large initial expenditure.
b. The establishment of a plant of a character too greatly in advance of local markets.
c. A plant of an unbalanced character, requiring orders representing a large tonnage of one product in order to keep it running.
d. Too great reliance on subsidies, which, while possibly necessary, and justifiable for that reason, in the initial stages of a hitherto untried industry, should not be regarded as part of the permanent income of any enterprise.

It must also be confessed, without any desire to dampen enterprise, that conditions have not in recent years been so adverse in the steel industry as they are at this time. Adverse exchange rates, high transportation costs, high fuel costs, and a lack of demand for steel products may, by their repressive action upon production, prove to be the medicine that will restore the steel industry to normal health, but, at this time, they are deterrents to new enterprises.

We would further suggest that the possession of large reserves of moderately priced fuel supply, and the assurance of commensurately permanent sources of ore supply, have hitherto been regarded as first essentials of steel manufacture.

STEEL SHIPBUILDING IN CANADA.

With the launching of the "Topdalsfjord", from Canadian-Vicker's yard on May 5th, the work of building steel ships in the Montreal district has come to a close, and the industry will revert to the smaller status of repairing and dry-docking. A similar reversion will take place in Halifax when the two ships now under construction are completed, and at the other shipyards on the Pacific Coast and the Great Lakes. Steel shipbuilding in Canada, as it has been developed during the past five years, will be remembered, as is now the munitions industry, as an example of what this country can do in case of necessity.

How soon steel-shipbuilding will revive as a permanent and growing industry, evolving from the necescast, but that such an evolution must come, no one sities of Canada's maritime commerce, no one can foreshould doubt. It is unfortunate, but seemingly unavoidable, that not one of the many fine shipyards in Canada should at this time be able to look forward to a date when the costs of ship construction in this country will permit of open competition with the rest of the world. The yards that have persisted in operation to this date, in spite of untoward trade conditions, have by that persistence, however, proved themselves to possess elements of permanence, arising from location and a real need for their existence, that justify a belief that at a future date they will be the first to make a recommencement in ship construction in Canada, whenever the due date may arrive.

Canada is now possessed of a number of well-equipped ports. Halifax, Montreal and Vancouver are three typical ports, having modern dockage and freight-handling facilities, and a hinterland that has not yet developed its full capacity to yield outward freights or to absorb inward freights, and large in capacity to the available freights as the Canadian Mercantile Marine may appear at this time, it would be incorrect to suppose that Canadian interests yet own any considerable portion of the freighting and passenger vessels that use this country's ports, or carry our coastwise traffic. As our maritime commerce grows, there will naturally develop an intention and a desire in the policies of Canadians to use ships that are built in Canada, that are registered under Canadian laws and subject only to Canadian regulations. In this regard it is just as important that the Canadian maritime commerce shall be controlled by this country as it is important to the

United States to control its maritime trade. The difference is merely in degree.

What the Canadian Government can do to hold the dying shipbuilding industry in being until the renaissance that can be foreseen, is difficult to say, in view of the financial obligations of the Dominion and a lack of unanimity among Canadian citizens as to the degree of industrial independence it is desirable Canada should seek to attain. It is desirable, were it possible, that one or more at least of the existing yards should be enabled to continue in operation until the day when the world shall resume the arts of peace, and Canada gets a chance to profit from her capital expenditures of the past quarter-century.

GOVERNMENT RAIL AND COAL ORDERS.

The Government has given an order for 50,000 tons of rails for the Canadian National Railways to the Algoma Steel Corporation, and stands ready, it is understood, to give a similar order to the Dominion Iron & Steel Company, if that concern will quote a price to meet American competition. The Minister of Railways sees no reason why rails should cost more now than they did last year, ignoring the fact that another department of the Government was largely instrumental in arranging a heavy increase in miners' wages last November. The stand taken by the Government, both in regard to coal for the locomotives and rails for the track of the National Railways is that miners' wages must be reduced, and the administration is unloading upon the companies the difficult task of enforcing such a reduction, because, as is well known, it is the production cost of fuel that sets the production cost of steel rails at Sydney. If the Government desires to get coal and rails at U. S. prices it will have to place its orders in the United States. There is a disposition at Ottawa to ignore altogether the limitations of Canada when they desire to purchase material, and it seems to be assumed that coal is just coal wherever it is found, and that if it costs more to mine in Nova Scotia than it does in Pennsylvania it is self-evident confirmation of incompetence in Canadian operators. If Canada is to become self-contained and self-sufficient in the day of testing, our statesmen will have to cease the everlasting measurement of our economic achievements and industrial ability against the standards of the United States. We cannot, it may as well be admitted, compete in an even contest with the United States in any industrial achievements that are based on coal, and will anyone name industrial activities that are not ? Any administration that relentlessly pits our weak and exotic steel industry against the world-overshadowing steel industry of the United States may not be seeking to compass the destruction of Canadian steel plants, but if they pit the weak against the strong what other result can they look for? The proceedings of the Fuel Committee in Ottawa have been punctuated by crescendo exclamations of astonishment that Nova Scotia coal cost so much more to mine than does coal in Pennsylvania, and this ancient knowledge, which is burned into the consciousness of the coal operator by a half-century of hopeless fighting against uneven odds, was received in Ottawa as something new, something to be astonished about, and something to be remedied. Instead of recognising the incalculable economic value of Nova Scotia coal, that miracle of preservation in a half continent of coalless Canada, there seemed to be a half-expressed resentment that Canadian railways and industries should be asked to support an industry that could not quote dollar for dollar for its product against the coal of the United States. The combined result of the sparing hand of Nature, of a hundred years working of the coal deposits, of twenty-five years of screwing down of selling prices to the United States minimum, of tremendous enlistments of miners in the War, of forced ship-requisition, and inflated currency, is all laid to the discredit of the coal companies.

This is a curious method of assuring the future fuel supply of Canada.

In regard to the actual price of steel rails, the Sydney "Record" quotes the Minister of Railways as stating that steel rails are offered in the United States at $47 per ton, and that in view of wage reductions and slack demand in the United States "it is not considered reasonable that the government should be called upon to pay an increased price for rails in 1921." The Minister does not explain what the price of steel rails in the United States has to do with their cost in Canada, which is a pity, as this is precisely where the people of Canada would be interested.

The "Record" states that a base quotation of $47 in the United States would be added to as follows. An addition of $1.60 per ton for the C. N. R. "nick and break test" is necessary. Duty is $7.84, and prevailing exchange will add $6.07, making a total cost, without freight charges, of $62.51 per ton.

The Algoma Steel Corporation has, according to the Minister of Railways, been offered the same price as last year, namely $55 per ton for rails, but the price at which the order for 50,000 tons was recently taken is not known.

Thus, it would appear, the Government offered the steel companies a price which is seven dollars a ton less than the cost of American rails to themselves, *without freight*. If there is any desire to help the Canadian steel companies that desire has not obtruded itself.

HYDRO-ELECTRO MACHINERY MANUFACTURE IN CANADA.

A witness before the Fuel Committee of the House of Commons stated that the large machines now used for hydro-electric power development in Canada are usually made in the States and are imported into Canada "even when purchased through Canadian firms who are the builders of the smaller electrical units." This witness expressed the opinion that duty-free ad-

mission of hydro-electric material and machinery from the United States into Canada would result "in a distinct increase of power production" in Canada.

The readers of "Iron & Steel of Canada" are aware that no branch of the secondary processes of the iron and steel industry in Canada has in recent years shown such growth as the manufacture of hydro-electric machinery, and, as this column pointed out in the last issue, Canadian manufacturers have equipped themselves to produce larger water-power units than have hitherto been projected in any country. Remission of the duty on hydro-electric machinery, stated this witness, would not cause the Government to lose any revenue, as "no one can be said to lose by giving up that which they have no chance of obtaining."

The same witness urged the duty-free admission of mining machinery and distillation equipment for utilization of Canadian oil-shales, although his argument was weakened by the admission that no important development had as yet taken place in utilization of the oil-shales in the United States.

Without dealing specifically with the economics of these two largely undeveloped sources of light, heat and power in Canada, we desire to register a general objection to the implied statement that Canadian resources must be developed by the material aid and the engineering advice of the United States. If there is anything striking in the development of Canadian natural resources up to this date, it is the fact that the special conditions found in Canada have called forth a special technique, native to the country, and not excelled in kind. The adaptability of the Canadian in the engineering problems of the war is not gainsaid and the best of reasons exist for this adaptability. The Canadian has a unique capacity for making the best of material resources, which is a combination of his heritage of natural selection from pioneering fathers, and unique natural obstacles that have been overcome in developing the Dominion itself. Canada is, has been, and will be, a leader in water-power developments. Much of the technique has been developed here, and is native to our soil. But for this power of adaptability to environment the Canadian would not have persisted as he has done, would long ago have disappeared as a type and have been merged into the population of the United States because of the lack of the fundamental element of progress. This spirit in the Canadian is as the shell that protects the crustacean from his enemies, and those who seek to weaken independence and initiative in Canada by suggesting our inability to help ourselves are dangerous, because their arguments subvert the spiritual strength of the Canadian people under the guise of material advantage.

This country has lean, refractory ores of iron. It is proceeding to develop processes that will improve their physical condition. We have large quantities of lignite, possessing unsuitable fuel characteristics. We are succeeding in making lignites available as a substitute for anthracite. Canada has large peat areas. Certain technical advances have been made in Canada in utilizing peat that are to be credited entirely to Canadian work. The utilization of oil-shales is a certainty of the future, and when it comes, it is more than likely that it will be brought about by the development of a special technique in Canada to suit the Canadian variety of shale. Canadian metal-ores of complex constitution have been made amenable to commercially profitable separation by home-grown methods. Canadian forestry is a distinctly national development. The list of similar national achievements is too large to instance further, but leading them all is water-power development, in which this country plays second-fiddle to none.

EXPORT OF WABANA IRON ORE.

The Bill before the House of Assembly in Newfoundland proposed to confirm an agreement between the Dominion of Newfoundland and the steel companies in Cape Breton now forming part of the British Empire Steel Corporation, is an important measure, which reflects a desire, actuated largely by necessity to pay Newfoundland's heavy war expenditures, to obtain a greater revenue from the iron-ore deposits of Wabana that form so large a proportion of Newfoundland's sources of material wealth. The ore deposits are owned in fee simple by the associated steel companies, and royalties cannot be imposed, which explains the imposition of export taxes. The agreement is important to the companies interested inasmuch as it limits their liabilities arising from projected increase of iron-ore output to a prescribed amount during a stated period, and this is an advantage where electoral governments change quickly.

The provision which refers to a projected blast-furnace plant in Newfoundland has probably in mind certain affiliations with British steel-making companies, and changes in the British coal industry that might make it preferable to ship pig-iron from Newfoundland instead of ore, although such a proposal would involve the bringing of coal to the blast furnaces from Cape Breton, or other point of supply. Should this project not be consummated, however, the burden of the agreement would appear to be that a maximum export tax of ten cents per ton will be imposed on iron ore shipped to points other than points in Nova Scotia. Newfoundland benefits immediately by an increase from 7½ cents per ton to 25 cents per ton upon ore shipped to Nova Scotia. Normal operation of the Cape Breton steel plants would call for annual ore shipments of between 800,000 and 1,000,000 tons.

INDEX NUMBER.

This issue contains the Index to Volume Two of "Iron and Steel of Canada" beginning February 1920 and ending January 1921.

The Canadian Steel Industry and the Direct Process

An Introduction of the Bourcoud Open Cycle Direct Process and its Economical Possibilities Under the Present Conditions of Canadian Iron and Steel Industrial Development.

By NOEL STATHAM.*

Introduction.

The future development of the metallurgy of iron and steel in Canada, with the view to establishing the industry for the entire domestic consumption, necessitates a very careful survey of the national resources and the best and most economical utilization of domestic raw materials. The permanent establishment of a great steel industry in this important part of the British Empire should depend for its basic requirements on Canadian iron-ore, fuel and hydro-electric energy. In some parts of the country, of course, an established industry must depend upon raw materials to economically sustain and operate blast-furnaces on account of the lack in the neighborhood of domestic coking coal; but from an economic point of view, such a general solution of the problem is undesirable, resulting in a permanent loss of revenue to the country. Canada, to be independent, must rely on domestic raw materials as far as possible, and develop the most economical and appropriate methods of manufacture, to take full advantage of what she actually has or can replace in substitution for what she has not.

A short survey of the present status of the industry shows that Canada has two important iron-producing districts—Nova Scotia, with 35% of the total, and Ontario with 65%. They represent the bulk of the domestic steel and iron manufacture of the country, but are based on widely different economic conditions. Nova Scotia produces its own coal and obtains iron-ore from deposits, owned by the steel companies, in Newfoundland; while Ontario imports both from the United States. In contradistinction to these two cases of established industry, British Columbia produces practically no iron, although possessing large deposits of good ore calculated to contain many millions of tons, and is producing at the present time more than two and one-half million tons of good coal annually. Under such distinctly favorable conditions, no one can doubt the feasibility of establishing there a steel industry, not only for Canada but also for the Pacific Coast in general, based upon a good home market, the Pacific Coast requirements of the United States, and possibly a large export trade. Attractive from a purely financial standpoint as this should be to Canadian manufacturers, initiative seems to be lacking, and from indications, the opportunity has already been taken advantage of by powerful interests in the United States and it is stated that blast furnaces will be established on Puget Sound (United States), importing both iron-ore and coal from Canada, thus reversing the case of Ontario and taking from British Columbia the initiative—or at least offering serious competition to any Canadian steel industry which may be established there, unless Canada adopts promptly newer and more economical methods of manufacture.

On the other hand, in spite of what has been speculated in years before, it is now generally recognized that the electric smelting or electric blast-furnace has been overestimated, and cannot give a complete answer to the iron and steel problem for Canada at the present time, inasmuch as hydraulic power should be more desirable and profitably used in other activities such as traction, general manufacture and household use, where the employment of coal is infinitely more wastefully used than in the metallurgy of iron, and can pay more remunerative price for power. The best that can be expected to be found, when possible, is a suitable cooperation of fuel and hydraulic resources.

Direct Processes.

Some prominence has been given recently in technical journals to new methods for the direct reduction of iron-ore based upon powdered fuel as the reducing agent; and it is the object of the present article to describe in some detail and from an economical standpoint, a new process effecting the complete reduction by means of proper reducing gases. Such a process, which is known as the "Bourcoud Open-Cycle Direct Process" has been thoroughly investigated and favorably reported on by the U.S. Bureau of Standards and the U. S. Bureau of Mines at Washington. The process is the result of exhaustive work and investigation by A. E. Bourcoud, who has interested himself in this problem since 1906, covering the entire field of research in experimental and practical development of the metallurgy of iron and steel by direct methods. Bourcoud's preference for a gas reduction is based on his own experience and general knowledge of the subject. In his reasoning he points out that the reduction of solid iron-ore with solid fuel is physically impossible because of the lack of adequate contact, no matter what is the degree of fineness of the grain or homogeneity of the mixture. If practical results are, however, obtained with this procedure, it is only due to the beneficial effect or action of the gases evolved in the operation which completes the reduction. Were it not for these gases, the operation would be incomplete and faulty. If, then, the gases play the most important part in the critical period of reaction, it is evident that they can do the whole work if they are brought together with the ore under the right conditions. It is noteworthy to observe that the only direct process in industrial existence at the present time reduces magnetic concentrates with gases avoiding the contact of solid fuel. The process is a crucible one, the invention of Sieurin, working in Hoganas (Sweden). The ore is placed in layers, separated from the coal by layers of lime. The gases evolved have to pass through the lime and coal in a process of regeneration thereby becoming desulphurized and the reduction is practically complete with only traces of oxide.

The technical failures in practice of the direct processes are due to nothing more than the inefficient physical methods adopted rather than the lack of chemical action. This would take place according to theory if the working conditions had been the necessary ones. Economical failures also of direct processes may be caused by an improper selection of the technical methods, making

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the [illegible] operation [illegible] impossible or difficult to realize in practice even with the most perfect theoretical reactions, the result being loss of energy and waste. The economic conditions of direct processes, like any other metallurgical operations, change with the percentage of metal contained in the ore at disposal; rich ores being preferable to poor ores on account of the smaller amount of gangue to be melted and slagged off. It also influences, to a great extent, the initial cost per unit of production. Direct processes have been always proposed in connection with very rich iron-ore. However, a direct process, even if imperfect, can give an economical solution in places where no other means of manufacture would be possible, its possibilities being in this case, a matter of making iron in a particular location or of not producing iron at all, and its field of utilization is therefore restricted and confined. But for a direct process to succeed in the same place with ordinary iron-ores and in open industrial competition with our present methods of manufacture, with all the wonderful accumulated improvements, large units, stable operation, interchange of surplus energy, etc., is entirely another matter and a most difficult problem which, if it were solved, would command a prominent place among the innovations in our principal and basic industry.

Bourcoud has directed his investigations with this end in view and the simplicity and soundness of his expositions have not been disputed. The solution offered by his process, therefore initiates great economic consequences. The fuel possibilities are extended by the use of the process, from low-grade lignites to oil, including the use of good coking-coal as well. The case of Ontario is within this latter order and is most interesting, as demonstrated by the data presented in tabulated form.

The inventor, although possessing in a marked degree the scientific knowledge required to explain and translate the theory of reduction taking place in the blast-furnace (from which he has derived his theoretical data), and applying these fundamental laws of reduction in a new direction; has also the advantage of a thorough engineering and technical training together with a practical experience in engineering problems involving the handling and operation of industrial plants. Such an unusual combination is rarely possessed by an investigator; and in present instance, is no doubt responsible for the comprehensive and logical manner in which theoretical considerations involved in the reduction of iron-ore in the blast furnace have been translated and applied by Mr. Bourcoud to place direct-steel production on a practical footing.

A comprehensive description of the process is given below, but it must be stated that the intent of this article is not to enter in detail into the technical merits and scientific theories of the process, as this would take considerable space and moreover, this aspect has been thoroughly discussed already by the U.S. Bureau of Standards and the Bureau of Mines in their special report to the Chairman of the War Industries Board in 1918 and later in 1919, by the School of Mines of the University of Minnesota, on behalf of the Bureau of Mines, who made very favorable reports and recommendations. The soundness of his theories and scientific deductions are here by these reasons admitted and considered settled for the moment under such unbiased indorsements. The main object of the present writing is to show the economical advantages possible to be derived with its application to the actual conditions of Ontario, without the necessity of taking account of, or waiting for, further new developments of her own iron-ore resources, at present unexploited, and possible fuels,—circumstances which should of course extend the application in a still more economical way,—but the problem at issue now and the question of moment is, that under present conditions and resources alone, the process may constitute a factor of the greatest importance, and is well worthy of an investigation by those interested, either the Provincial authorities, local smelters or by others with progressive ideas and independent movements.

Bourcoud Process.

On general lines and expressed in the shortest terms, the Bourcoud Direct-Process does not deviate sensibly from the traditional lines of direct production and consists in reducing iron-ore with gases at sufficiently high temperature, transferring the reduced metal (still solid) to an electric furnace where it is primarily melted and subsequently to another electric furnace where it is finally refined if required. In this process the reducing gases are generated by the gasification of powdered fuel. Up to the present time, in spite of the numerous trials and experiments made this logical and, in appearance, easy solution of the problem of the direct manufacture of steel has never been, by far, successfully realized, either technically or economically.

Such a simple enunciation of the successive operation involves, however, the solution of two important and vital problems which apparently never have had attention on the part of previous investigators and experimenters. They are namely:

First: How to generate a good reducing gas, and

Second: How to utilize it for reduction.

These two points are conjointly essential, as one of them without the other would fail to find the proper solution, and are an alternative to our present methods of manufacture. The solution has also to be economical and workable under all its aspects on large scale in order to take competitive industrial rank from the very beginning of its existence.

Before describing the process it may be explained that Fig. 1 and 2 show a complete unit of 280 to 300 tons of steel per day and Fig. 3, a complete plant of four units with a total capacity of 400,000 tons of steel per year as proposed by Mr. Bourcoud to the Brazilian Federal Government for Minas Geraes, and now under consideration.

The Bourcoud process may be said to comprise three main steps:

(1) The making of a high-temperature, pure reducing-gas from powdered fuel of almost any grade, including lignite. The process can also utilize oil.

(2) The reduction of ore in a special furnace by a new method, involving the continued and repeated physical contact or impingement of the gas and the charge which is pre-heated to the critical temperature before entering the reduction furnace..

(3) Melting of the sponge-iron produced in electric furnaces adapted to receive a charge of metal continuously from the reducing furnace.

It will be seen in the following description that these three steps have been so carefully correlated that the whole operation of manufacturing steel direct from the ore is a relatively simple matter (when viewed from a chemical-engineering standpoint), is continuous in

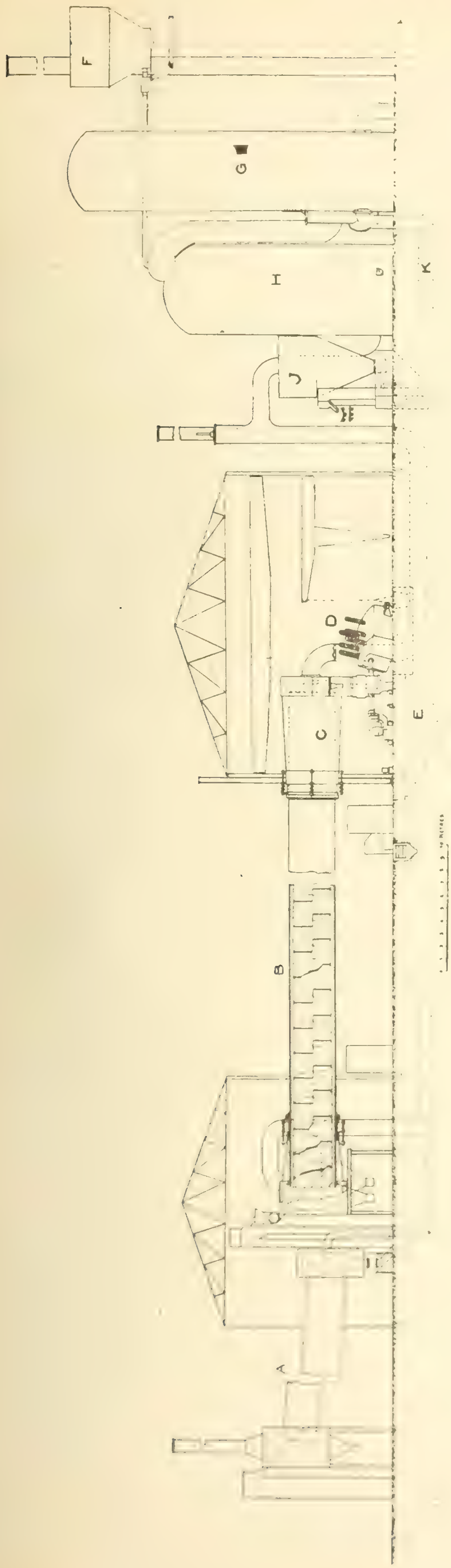


Fig. 1.—Elevation.

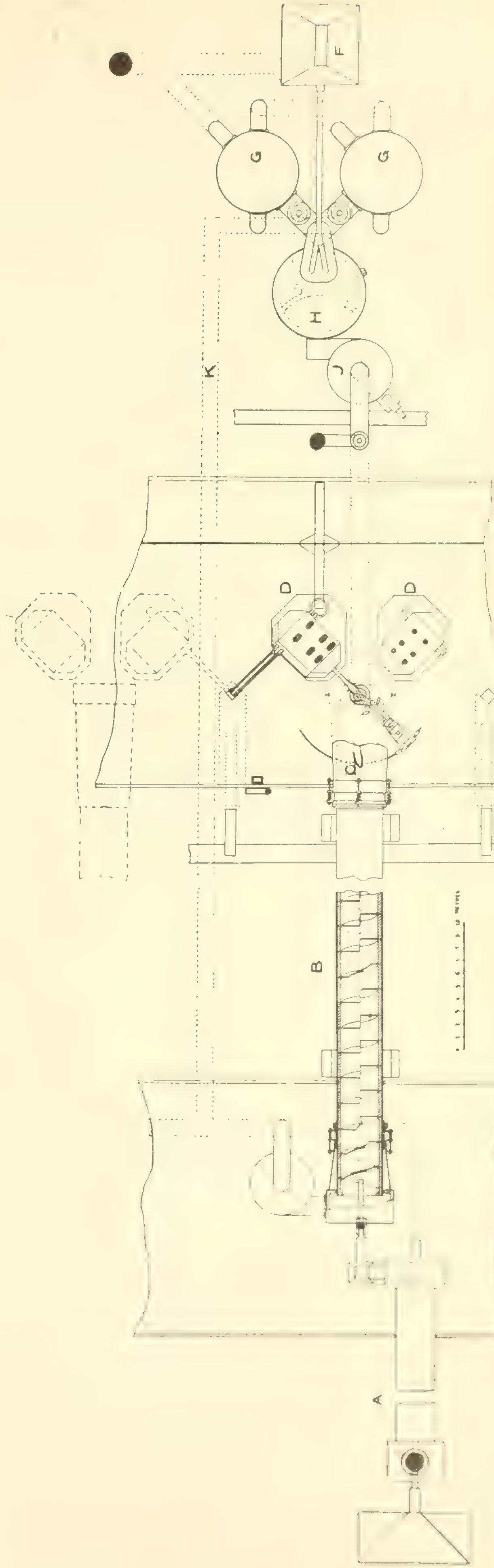


Fig. 2.—Plan of Complete Unit with capacity of 280-300 tons of steel daily. Bourcoud Open-cycle Direct-Process of Steel Manufacture.

operation, and at any time under the most complete control.

The first step in the process to be considered in this brief description is the Bourcoud powdered-coal gas-producer. (See "Gasification of Powdered Coal" by A. E. Bourcoud — *Chemical and Metallurgical Engineering* Vol. 24, April 6, 1921. — page 600). This consists essentially of a vertical tower, lined with refractory material, divided vertically into three chambers forming a long continuous duct or chamber, where the gasification of the fuel is effected upon the injection of coal-dust or oil, together with air heated in the ordinary type of stove to at least 500 deg. C. It was found that the essential factors in the production of a pure reducing-gas are **first**, the correct and necessary temperature of air for the particular fuel under treatment; and **secondly**, the time of contact necessary for the formation of the highest percentage of CO and hydrogen possible. Other investigators working on this problem have overlooked these two important points with distinctly unsatisfactory results. Ash in the form of liquid slag and dust are eliminated as far as possible from the reducing gas at convenient points. The temperature of the gases leaving the producer, after a complete gasification is about 1200 deg. C., and about 1000 deg. C. when introduced into the discharge end of the rotary reducing-furnace, meeting and reducing in its passage through this apparatus the pre-heated iron ore (temperature of preheat 700°/800° C.).

The reducing furnace is formed of a standard cement kilnshell, of the rotary type, lined with refractory material, provided with new form of expanding sleeves at each end to prevent escape of gas etc., and also containing as an integral part and rotating with the body, a continuous series of helical baffle-plates which cause the gas to successively impinge upon the body of the ore with the same or greater impact effect compared to the action of the reducing gases in the blast furnace. The result is that the ore is completely reduced during its travel through the furnace, being converted into sponge, which is forced continuously, while still very hot, through the trunnion of an electric furnace. Two electric furnaces are required for one rotary unit, one continuously operating slagging-off and intermittently discharging the molten metal while the other is kept as a spare for replacement and patching of lining.

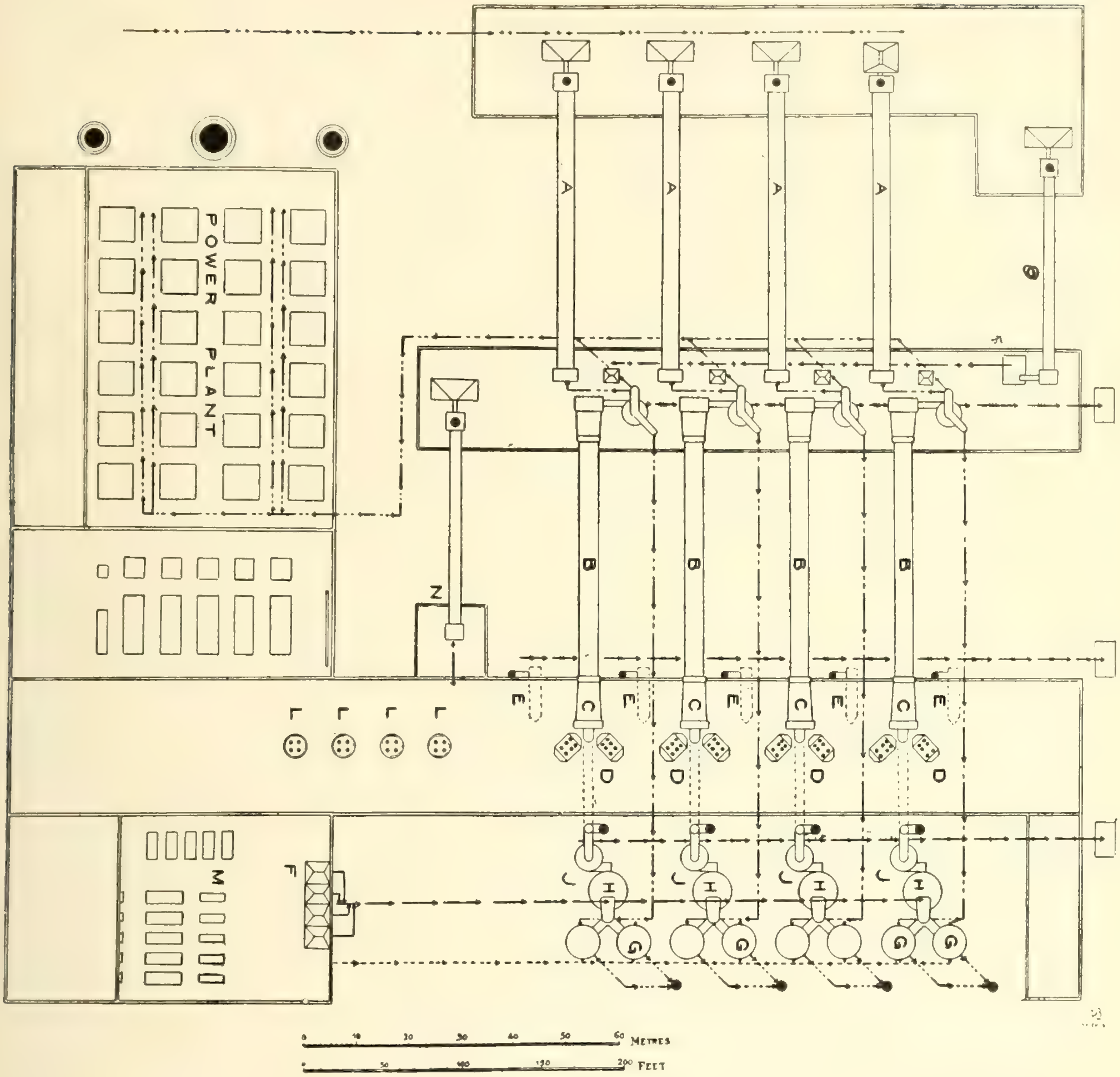
The helical arrangement of the reducing furnace, which at first sight may be obscure, seems to be a solution of the problem of the deoxidation of iron ore in a rotary furnace, which up to now, has been unsolved and the cause of the manifold failures in a practical sense of other processes using continuous rotary-furnaces. This practical method of carrying out the theoretical requirements of the direct process in which kinetic energy plays such an important part, represents long and arduous work by careful analysis of the theory of reduction, and is, I believe, offered by Mr. Bourcoud and applied in a practical form for the first time. This important phenomena, upon which hinges the Bourcoud Direct-Process, should be given careful study. The inventor and others have conclusively proved that a straight tube furnace or ordinary dimensions, either with raising ribs or plain, will not be suitable for intensive work, owing to the lack of contact, or proper conditions between the gas and the charge; and the length or number of such furnace for a given weight of product would be impractical. It has been found that to duplicate the blast furnace effect, a system of impacting arrangement is required.

Bourcoud shows from blast-furnace practice that the time necessary for the reduction of a given lump of ore of the average physical structure, at the average temperature in the gas-reducing zone of the blast furnace, is directly proportional to the square root of the diameter of the lump, and inversely to the square root of the kinetic pressure on the pole of the lump, due to the moving mass of reducing gases. By a proper selection of the convenient maximum of the grain composing the charge and by a proper spiral pitch governing the intensity of kinetic pressure for a given production, the reducing condition of the blast-furnace cannot only be duplicated, but greatly improved. The whole length of the rotary furnace would be a reducing zone, while in the blast furnace, five-sixths of the total static and kinetic pressure is wasted in other activites which have no beneficial action on the reduction of the ore.

The gases issuing from the reducing furnace may be considered equivalent to good blast-furnace gas, having still a large amount of sensible heat and potential fuel-value. They are used partly for pre-heating the ore charge in an ordinary type of rotary furnace, partly in the stoves to heat the blast for the gas producer, and the balance is used in the boiler-house or gas engines, as preferred or most convenient. The considerations of the fuel requirements of the process is affected by the kind of ore treated. The minimum practical volume of gases necessary to thoroughly reduce a charge of ore is not precisely the volume representing the combustion of gases necessary to supply the heat requirements of the system after leaving the furnace. It is generally less, and more fuel has to be accounted for in order to complete the operation. These heat requirements, as previously stated, are: (1) Drying and pre-heating the charge; (2) Pre-heating the primary air for gasification; and (3) Generating the electric power for the primary melters, refiners and all mechanical needs of the plant. The third item is the most changeable, depending on the kind of ore at disposal. Weight for weight, the melting of slag requires practically double the amount of energy taken by the melting of the metal. The case of Ontario with Lake ores, producing 0.40 tons of slag per ton of metal, necessitates additional supplies of fuel which can be replaced with hydraulic power if at disposal and at a reasonable price compared with the cost of fuel. Tables I and II and III deal with a semi-hydraulic direct-process in Ontario.

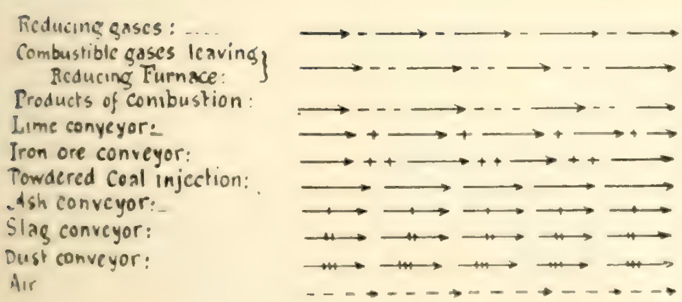
Rich ores like high-magnetic concentrates or Brazilian natural ores do not offer much opportunity for replacement, as the waste gases can produce easily all the heat and power required by the system. It is here that British Columbia is placed in a very favorable position, natural resources consisting of abundant coal, good magnetic ore and also concentrates therefore offer a new aspect for the direct processes under consideration; and the results should be still more advantageous. (See table IV).

With reference to the purity of the metal obtained, the preliminary roasting preparatory to the entrance of the iron ore to the reducing furnace, will eliminate practically all the sulphur from that source, while the sulphur of organic origin contained in the fuel used, should be converted into sulphur dioxide, which would remain undecomposed during the reduction.



BOURCOUD OPEN-CYCLE DIRECT-PROCESS OF STEEL MANUFACTURE.

Fig. 3.—Plan showing general arrangement for steel plant of 1,000 to 1,200 tons daily capacity, proposed to the Brazilian Federal Government for Minas Geraes.



Index to Lettering used on Figs. 1, 2 and 3.

A. Pre-heating Furnace.
B. Reducing Furnace.
C. Sponge-compressing and charging machine.
D. Primary electric melter.
E. Continuous slag-quenching pits
F. Powdered-coal bunker.
G. P. S. S. Regenerative Stoves.
H. Powdered-coal gas-producer.
J. Ash Catcher.
K. Cottrell Precipitator.
L. Intermittent electric-furnace refiners.
M. Gas-producer control-house.
N. Lime-kiln for electric furnace.
O. Lime-kiln for gangue.

The phosphoric acid of the ore will not be reduced by the gases at any temperature. It will then enter the electric melter as it was originally charged into the pre-heating furnace and will pass directly to the slag, inasmuch as the proper and necessary conditions for the reduction of phosphoric acid, are conspicuous by its absence or can be made so. To remove any trace of sulphur which the small amount of ashes in suspension in the reducing gases may have deposited in the charge, in spite of the great velocity of circulation in the reducing furnace, one slag refining has been considered. For calculating the operating cost, refer to Table 1, 2 & 3 Ontario, while three cases have been considered:

(a) Using fuel exclusively, and generating power with modern steam-turbines.

(b) Using fuel exclusively and generating power with large gas-engines.

(c) Using the minimum amount of fuel for reduction and obtaining the extra necessary power from an independent hydraulic supply.

In this latter case, with coal at $7.60 per ton, a direct-process installation would find the same metallurgical cost while paying for the supplementary hydraulic power from a Canadian power-company at the rate of .74c per K.W.H. (equal to $47.50 per H.P.Y.); but I am informed that an important supply of water power can be obtained at the rate of $36.00 per H.P.Y. Considering even a small water-power connection of 10,000 H.P., the total amount of steel produced should be about 130,000 tons, and a small steel plant, working with two units of 180 tons per day, would show a net decrease of coal imported into Canada of 130,000 tons with a value of $988,000 and also about 3,900 tons of iron ore valued at $23,000—a total of more than a million dollars per year saving in importations of coal and iron-ore by the adoption of the Bourcoud direct-process, utilizing supplementary Canadian hydraulic-power to the value of $360,000 per year. It may be of interest to cite the case of roasted siderite of Magpie type available in Ontario, which averages 50% iron. If this roasted ore were delivered into the reducing furnace at 750°C., eliminating that part of the exhaust gas necessary for drying and pre-heating of the charge, and this gas were utilized in gas engines, there would be considerable economy. In case "C" to which this corresponds, it would mean a saving of 275 K.W.H., or for one ton of steel to be produced, one ton of coal would be used with 220 K.W.H. additional water power. Gas engines supplying 820 KWH+220 Hydraulic =1040 KWH necessary per ton of finished steel using this kind of ore.

In the case of Brazil the consumption of imported English coal for starting the industry is estimated at 1.14 tons per ton of steel and the power would be all generated by steam turbines from the surplus fuel-gas of the process. The lignite resources of Brazil will replace, gradually, imported-fuel in the future development. With this direct process, Brazil can pass from a non-productive iron country to an important exporting centre, being able to deliver into England and the United States refined structural steel at as low a price as it could be produced by the same direct process in England or the United States. One of these units would produce, with Lake-class ore or 50%, about 180 tons per day each; and with British Columbia ore, about 240 tons, under a conservative estimate.

Conclusion.

Viewed by a steel metallurgist, the Bourcoud process may be considered as too revolutionary in character not only on account of the essential differences of blast-furnace practice, contact with which seems to be entirely lacking; but also from the fact that anyone should attempt, even with hesitation, to produce steel by apparently disregarding entirely the accumulated experience gained by steel manufacturers during the past 100 years. On the face of it, in considering the question only from one side, these criticisms seem to be correct, until a closer study is made of the subject, which will amply repay those interested in the iron and steel industry. Mr. Bourcoud has based his conclusions and practically started his investigations upon the unbiased assumption that however imperfectly, from a chemical viewpoint, steel is produced primarily from pig iron of the blast furnace, still this latter operation is an efficient one as regards the economical utilization of fuel, and its actual yield has reached such a point of excellence that little improvement is likely to take place in this industry through modifications in the existing type of apparatus.

If all the necessities of the metallurgical industry were confined to the employment of cast iron alone, there is no doubt that the incentive for economical improvement would find very narrow limits given our present state of advancement in the art; but on the other hand, if cast iron is considered,—as it ought to be in this case—as the basis for the production of steel, undoing the greater part of the efficient work which the blast furnace does, the combination as it exists today is by no means perfect, and it is in this field that a great opening is offered for an efficient and economical process for the direct production of steel, the object of which should be to reach the same level, at least, as has been attained by the blastfurnace in the direct production of cast iron. In viewing the problem from this point, therefore, the object of investigators should be not the improvement or modification of the blast-furnace, which is undoubtedly the most efficient apparatus for its particular function, but rather adopting its good points and avoiding its drawbacks wherever possible. This is emphasized very forcibly by Mr. Bourcoud in his original report, in which he gives as his opinion that a solution may be found with advantage by a radically different method, suppressing the unnecessary intermediate and dangerous zone which forms the link between the reduction of the oxide and the melting of the reduced metal, the two real achievements of the blast furnace.

Canadian industrial prosperity depends upon the pioneer work of public-spirited men of affairs, financiers and scientific investigators. Their influence on the future steel industry is of vital importance at the present time, in view of the undeveloped resources of the country. Canadian steel manufacture can well expand into one of the greatest industries of the Dominion and a factor to be reckoned with in the domestic consumption of iron and steel. It will owe a debt of gratitude to many distinguished workers of pure and applied science, among whom it is scarcely necessary to mention Professor Stansfield, of McGill University, whose research and practical assistance in connection with the iron and steel industry in Canada are well known. At the present time his activities in the field of direct reduction of iron ore are commanding gener-

al attention, which should eventually result in Canada at least taking the lead in a new direction, regardless of the natural prejudice encountered in the established industry of the present day. It is reasonable to expect, however, that as the Canadian steel industry of today is of comparatively recent origin, compared to the great development in other parts of the American continent, it will take a greater interest in new methods of manufacture—or at least be open to argument; and if such a result is accomplished in a minor degree by the foregoing description of the Bourcoud Process, the object of this article will have been achieved.

The relative economic position of Canada and the United States is such that the former country now depends, to a very great extent, upon importation of rails, structural steel, sheets, etc. from the latter, whose competition in the future will place a great burden on the Canadian steel industry. If this industry is to have an independent existence, it must be founded on a solid basis of low-cost production (see tables), scarcely possible of attainment by present methods unless accomplished on a scale comparable with that at Pittsburg or Gary.

TABLE No 1.

Province of Ontario, Canada.

BOURCOUD DIRECT STEEL PROCESS.

Consumption of Fuel.

Case (a) All fuel: power generated with steam turbines.
Case (b) All fuel: power generated with large gas engines.
Case (c) Semi-hydraulic. Part of power generated with gas engines (40 per cent) and the rest (60 p.c.) taken from an independent water power station.

IRON ORE: Lake Ore — 50 p.c. Fe — 10 p.c. moisture. Slag per 100 metallic iron — 40.

COAL: Typical Pennsylvania coking coal — dry analysis:

Carbon	80.25
Hydrogen	5.24
Oxygen	6.77
Nitrogen	1.49
Sulphur	0.79
Ashes	5.46
	100.00

REDUCING GAS IN POWDERED COAL GAS PRODUCER:

Temperature of primary air — average .. .. .. 500 deg. C.
Air used per 100 kg. powdered dry coal .. 325 cub. Met.

	100 kg. coal	100 cu. met. gas
Carbon monoxide	142.00 cu. m.	30.80 cu. m.
Hydrogen	56.60 cu. m.	12.20 cu. m.
Carbon dioxide	1.26 cu. m.	0.27 cu. m.
Water vapour	1.62 cu. m.	0.35 cu. m.
Nitrogen	260.00 cu. m.	56.38 cu. m.
	461.38 cu. m.	100.00 cu. m.

Calculated loss of (C) in ashes (5 p.c.) 4.00 kg. 0.87 kg.

All calculations are made
103 Kg. Fe = 100 Kg. finished steel:

	(a)	(b)	(c)
Coal gasified .. Kgs	162	137	100
Volume gas generated .. C. M.	740	630	460
Composition Gas Entering Reducing Furnace at about 1,000 deg. C., Cub met.:			
Carbon Monoxide	226.0	193.0	141.0
Hydrogen	90.0	76.0	56.0
Carbon Dioxide	2.0	1.7	1.4
Water Vapor	2.6	2.2	1.6
Nitrogen	419.4	357.1	260.0
Total	740.0	630.0	460.0
Composition Gas Leaving Reducing Furnace at about 700 deg. C. Cub. met.:			
Carbon Monoxide	182.0	149.0	97.0
Hydrogen	72.0	59.0	38.0
Carbon Dioxide	46.0	45.7	45.4
Water Vapor	20.6	20.2	19.6
Nitrogen	419.4	357.1	260.0
Total	740.0	630.0	460.0
Degree of Saturation, leaving:	0.205	0.242	0.320
Heat and Power wanted per 100 Kg. Steel:			
HEAT: K. Cal. for drying and pre-heating ore	59,000	59,000	59,000
K.C. for pre-heat. prim'y air	83,000	71,000	52,000
POWER:			
For melting sponge iron ore 60% eff. K.W.H.	32.00		
For melt. slag 60% eff. K.W.H.	24.8		
Total in primary melter K.W.H.	56.8		
For final refin., 45% eff. K.W.H.	19.0	same	same
Total in electric furnaces K.W.H.	75.8		
Complete mechanical needs of plant	6.5		
Total K.W.H. cap'y for power house	82.3		
Calorific value of gases leaving Reducing Furnace: (2% leakage) .. K. Cal.	830,000	638,000	412,000
Uses:			
Drying and preheating charge, — 30% eff. .. K. Cal.	196,000	196,000	196,000
Preheating primary air — P.S.S. regenerator 60% eff. .. K. Cal.	139,000	118,000	87,000
Available for power purposes K. Cal.	495,000	324,000	129,000
	830,000	638,000	412,000
In modern power house with constant and permanent load:			
Steam turbines at 6,000 K Cal. per K.W.H.	82.3		
Large gas engines at 3,900 K. Cal. per K.W.H.		83.0	32.8
Additional water power			49.2
Total power .. K.W.H.	82.3	83.0	83.0

TABLE No. 2.

Province of Ontario, Canada.

DETERMINATION OF THE METALLURGICAL COST, PER METRIC TON.

Approx. Cost of Ordinary and Refined O. H. Steel.

Basis::

Iron ore, non-Bess. 50%	per ton	$ 5.90
Coal	per ton	7.60
Coke (by-product Oven)	per ton	10.30
Powdered coal (7.60 + 0.40)	per ton	8.00
Limestone	per ton	1.50
Working expenses = U. S. pre-war + 80%		
Cost of plant = U. S. pre-war + 80%		
Water power	H.P.Year	$36.00
	K.W.Year	48.00
	K.W.Hour	0.56

Pig Iron:

Iron ore	1.84 tons x $5.90	$10.86
Coke	1.10 tons x 10.30	11.33

Limestone	0.47 tons x 1.50	0.70
Working expenses		2.80
	Sum	$25.69
Blast Furnace surplus gases in coal heat equivalent		1.12
Metallurgical operations TOTAL TON OF PIG IRON		$24.57
Open Hearth:		
Pig Iron	1.16 tons x $24.57	$28.50
Coal	0.30 tons x 7.60	2.28
Working expenses		4.97
Metal. Operations TOTAL ORDINARY O. H. STEEL		$35.75
Electric Refining 1 slag: (Gas Engines)		2.54
Metal. Operations TOTAL REFINED O. H. STEEL		$38.29

BOURCOUD DIRECT STEEL PROCESS:

(a) All fuel. Power by steam turbines.
(b) All fuel. Power by gas engines.
(c) Semi-hydraulic. Power by gas engine (40% and hydraulic supply (60%).

		(a)	(b)	(c)
Iron ore, ...	2.05 tons x $5.90	$12.10	$12.10	$12.10
Powdered coal x $8.00 ..	1.62 tons	12.96	....	....
	1.37 tons	....	10.96	....
	1.00 tons	....	....	8.00
Working expenses		7.25	7.25	6.55
Hydro power, 495 K.W.H. x c 0.56		....	....	2.77
Metallurgical Operations TOTAL COST DIRECT STEEL		$32.31	$30.31	$29.42

Relative cost:	Ordinary O. H.	100	90%	85%	82%
	Refined O. H.	100	84%	79%	77%

TABLE No. 3.

Determination of the Economic Factors: **Per Ton per year.**
(I) Minimum Industrial Cost,
(II) Minimum Profitable Market Value, and
(III) Ratio to Capital Investment.

	O. H.Steel		Refined Steel by the Burcoud Direct Process		
	Ordin'y	Ref'd	(a)	(b)	(c)
Cost of plant	$43.80	49.00	35.50	33.00	22.50
Working Capital — 25% cost of metal. operations	8.90	9.50	8.10	7.60	7.30
(K) **Capital Investment** ..	$52.70	58.50	43.60	40.60	29.80
Relative value	100	...	83	77	57
	...	100	73	70	52
Cost of metal. Operations	$35.75	38.29	32.31	30.31	29.42
Fixed charges — 10% (K), for reserv. depr. and taxes ..	5.27	5.85	4.36	4.06	2.98
(I) **Industrial Cost**	$41.02	44.14	36.67	34.37	32.40
6% interest on (K)	3.15	3.50			
(II) **Minimum Profitable Market Value**	$44.17	47.64			
(III) **Ratio to Capital**					
(Mo) = Margin, (II) — (I), ordinary	$ 3.15	....	7.50	9.80	12.37
(III) **Ratio to Capital** (Mo) ÷ (K) = ...	6.%	....	17.2%	29.1%	41.5%
Relative value	100.	....	287.	485.	690.
(Mr) = Margin, (II) — (I), refined	....	3.50	10.97	13.27	15.24
(Mr) ÷ (K) = ..		6%	25%	33%	51%
Relative value	....	100.	418.	550.	850.

TABLE No. 4.

Cost per Ton of Steel by the Bourcoud Direct Process.

British Columbia.

Approx. Cost of Refined Direct Steel.

Iron ore of 64%	1.62 tons at $5.50	$ 8.90
Powdered coal	1.25 tons at 6.50	8.10
Working expenses		7.25
Total Metallurgical Operation Cost		$24.25
Per Ton per Year.		
Cost of plant		$29.00
Working capital		6.10
Capital Investment		$35.10
Cost of Metallurgical Operations		$24.25
Fixed Charges		3.51
Industrial Cost		$27.76
6% on Capital Investment		2.10
Minimum profitable market value		$29.86

TABLE No. 5.

Industrial Thermal Efficiency.

1 kg. coal	K. Cal.	8,000
1 kg. coke, requires 1.50 kg. coal.		
1 kg. coke, produces in surplus gas (oven) ..	K. Cal.	752
1 kg. coke, — — (blast. furn.)	K. Cal.	1,085
1 kg. coke, produces in total	K. Cal.	1,837
or in % of the calorific value of the coal		15%

1 kg. pig iron requires (50% ores) 1.10 kg. coke (1.40 net coal).

1 kg. O. H. Steel, with losses, requires 1.16 kg. pig iron (1.62 net coal).

Net coal required, per kg. O. H. ord. Steel in the production of iron charge	kg.	1.62
Coal in gas producers, per kg. ord. steel	kg.	0.30
Total net coal per kg. ord. O. H. Steel	kg.	1.92
		15,360 K. Cal.
Refining (1 slag) power generated with blast furnace gas engines, net coal equivalent	kg.	0.08
Total net coal, per kg. refined O. H. Steel	kg.	2.00
		= 16,000 K. Cal.
1 kg. iron requires for reduction	K. Cal.	1,746
Sensible heat in 1 kg. Steel in the ladle	K. Cal.	348
Total heat requirement per kg. of steel ..	K. Cal.	2,094

or equivalent in coal to 8,000 K. Cal. 0.262 kg.

		Open Hearth Steel		Bourcoud Direct Process	
		Ord'y	Ref'd	(a)	(b)
Net Coal consumption	kg.	1.92	2.00	1.62	1.37
Industrial Thermal efficiency	%	13.6	13.1	16.2	19.2
Relative value versus Refined	%	...	100	124	147

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IRON AND STEEL INDUSTRY FOR BRITISH COLUMBIA.

By E. A. HAGGEN (from Mining and Engineering Record, Vancouver B.C.)

An iron and steel industry in British Columbia is assured, and will be established by a British firm that already operates a large iron and steel plant in another part of the British Empire. The credit for the establishment of the industry is due to Ex-Mayor Jas. Findlay. Mr. Findlay was one of the first men to volunteer for war service in 1914, and being a mechanical engineer was given charge of important works in England operated by the British War Department. Before returning to Canada at the close of the war he got in touch with a British firm engaged in the iron and steel business, who were open to establish a plant on the Pacific Coast provided conditions appeared favorable. They retained Walter D. Rock, an eminent coal and iron engineer, who had rendered specially valuable service to the War Department in the utilization of coal for the manufacture of explosives, his work in the production of T.N.T. being particularly successful.

History of the Investigation.

Mr. Rock was engaged during the years 1918-20 in the investigation of the prospects of an iron and steel industry in British Columbia, and made several trips between England and Vancouver in connection with the work. He thoroughly investigated the iron ores and coals of British Columbia, as to their suitability in the manufacture of metallurgical coke, and had shipments of the ores and coal sent to England for exhaustive tests. He was a man of retiring disposition, and realized that the ultimate results of his work depended on long and patient investigation before making any announcement as to the nature of his work or the intentions of his principals. At Vancouver, newspaper reporters got some information as to the nature of his business and sought to interview him, when he put them off with the remark that his business in British Columbia was "buying apples."

During his investigations he was continuously in touch with Mr. Findlay, who is the representative of the company in British Columbia. He had completed his work, and was about to return to England last fall when he was taken suddenly ill and died, his health having been completely undermined by his patriotic war service.

The results of his investigations were satisfactory to his principals and they have decided to go ahead with the industry. For a time negotiations were carried on with the Canadian Collieries, Ltd., with a view to the acquisition of their coal and iron holdings, for this company has one of the best magnetite iron ore properties in the Province, located on the west coast of Vancouver Island. On this property is an actual reserve of 5,000,000 tons of high grade magnetite, with further extensive probable and possible reserves. The Cumberland coal field operated by the company has also had the reputation of supplying the best metallurgical coke tributary to the Coast.

Site of Industry.

Some hitch arose in the negotiations with the Canadian Collieries, Ltd., and the deal fell through. Had it been consummated, Union Bay, on Vancouver Island, would have been chosen as the site of the iron and steel works.

Investigations of the Nicola coal fields showed the coal deposits there were well adapted to the manufacture of metallurgical coke in a by-product plant, and this fact, coupled with convenience of transportation on Burrard Inlet or the Fraser River for receipt of ore by water, decided the vicinity of Vancouver as the site for the industry. The firm's representatives are now on the way from England to select the site for the works and carry out the plan as recommended by Mr. Rock.

Method of Operation.

The company is strongly financed, with a first-class directorate. It will not tie up its capital in the purchase of coal or iron ore properties, but will install a by-product plant for the manufacture of its own coke supply and utilization of the gas and other by-products, purchasing the coal required under contract. The ore supply will be treated in the same way. The company will purchase ores offered of suitable quality and quantity, but owners of iron ore properties must do their own mining. The company, on the other hand, will assist in financing the equipment of properties carrying approved ores with the necessary mining and transportation plants to enable the owners to supply the ore in the event of their not being in a position to finance the development and equipment themselves.

The ores used will be a mixture of magnetite and hematite in furnace charges of ton for ton, the investigation carried on having demonstrated that pig iron can be most economically and efficiently produced from coast magnetites with this mixture. The hematite will be imported from Mexico or California.

Export Trade.

The company recognizes that the local market for iron and steel is limited, and that to take care of the surplus product an export market must be developed. With their extensive iron and steel trade connection the management knows where to place the surplus product, and it is this feature of the firm's organization that enables it to undertake with confidence the establishment of an iron and steel industry on the Pacific Coast at Vancouver.

An iron and steel industry in British Columbia has been a dream of many years. The nearest approach to it was the scheme propounded by Mr. Valentine, a Scotch ironmaster, about 20 years ago. Mr. Valentine came to British Columbia and decided to make investments here. He bonded the Britannia Mine and made a heavy payment on it. He arranged to establish an iron and steel industry also; but on his return to Scotland to complete his plans he died, and with his death the schemes he had outlined fell through.

About seven years ago a California syndicate took the matter up, after two years of investigation, but decided on Puget Sound as the best site for the industry, though proposing to use British Columbia and Alaska magnetite mixed with hematite from Mexico or California, the furnace mixture to be two tons of hematite to one of magnetite. This scheme fell through as the result of the war, when the plans for financing it had to be dropped.

About the same time H. Landahl, the principal promoter of the Coast Range Steel Co., Ltd., acting as agent for the late Henry Hewitt, of Tacoma, proposed to establish an iron and steel industry, the chief feature of which was to be a large bond issue by the Provincial Government, most of this bond issue to go to Mr. Hewitt in payment of iron ore properties he held in British Columbia. In other words the Government

was to buy back at a high price its own iron ore assets which Mr. Hewitt had acquired at a nominal price. The Vancouver Board of Trade was asked to assist the project and appointed a committee to investigate it. That committee reported unfavorably, and the project was dropped until revived recently in the promotion of the Coast Range Iron and Steel Co., Ltd., in another form.

Other iron and steel promotions are the Vancouver Magnetite Company which proposes to produce pig iron by a duplex process; the Shipton Electric Iron and Steel Co., Ltd., which proposes to produce pig iron from ore by an electric process; and the Steel Smelters, Ltd., a Seattle Company, which claims to produce steel direct from ore and has been mining ore for the purpose at King Island, British Columbia.

DOMINION FOUNDRIES & STEEL, LIMITED, INSTALL 27-INCH UNIVERSAL MILL.

The Dominion Foundries & Steel, Ltd., of Hamilton, Ont., has installed a 27-inch universal mill made by the McIntosh & Hemphill Co. of Pittsburg. The mill can roll universal plate from seven inches to forty-one inches, and shear-plate up to 64 inches, and will also roll slabs and billets.

The Company proposes to roll slabs and forging billets to provide stock for its own plough and jobbing mill and for the axle forge shop. Special forging billets, for locomotive and marine forgings of heavy type, can also be rolled on the new mill.

The mill has a capacity of 150,000 tons annually, and its varied capacity is such that it is hoped it will enable the Company to supply much steel that it has hitherto been necessary to import from the United States, including structural plate for bridges, buildings and railway cars; sheet-bars, heavy pipe-skelp, etc.

Mr. Sherman announces that the installation of this universal milll is a result of many years study of the steel market in Canada which had led him to the conclusion that a universal steel-plate mill was badly needed in Canada to take care of domestic requirements. A glance through the tremendous list of imported steel products, and study of their rapid annual growth, will show that Mr. Sherman is right, insofar as the necessity to supplant this imported list by rolling in Canada is concerned. It is significant to note, at the same time, that the blast-furnace and steel-refining capacity of Canada is still where it was in 1908.

STEEL PLANT PROPOSED FOR SUDBURY DISTRICT.

Appearing before the Private Bills Committee of the Ontario Legislature recently, R. U. McPherson, counsel for the Mond Nickel Co., Sudbury, strongly opposed the bill introduced by Col. W. H. Price for the incorporation of the Fecunis, Limited, a mining and smelting concern, with head office in Toronto, and asking permission to build a light railway, 20 miles, to connect their properties with the C. N. R. and the C. P. R. J. M. McEvoy, representing Fecunis, Limited, admitted that the railway would run over part of the Mond Company's land. The incorporation would result in a new company being opened up, with a new invention for the treatment of steel. It developed that this was known as the "Burrows process", which, Mr. McPherson claimed, is in an experimental stage. The bill was reported with some minor changes.

CAPE BRETON STEEL COMPANIES CONCLUDE AGREEMENT WITH NEWFOUNDLAND ON COAL AND ORE INTERCHANGES.

In the Newfoundland House of Assembly on April 27 a bill to confirm the agreement between the Government of the Colony and the Dominion Iron and Steel and Nova Scotia Steel and Coal Companies, was distributed. The St. John's Daily News says that the old arrangement, which expired at the end of 1919, provided for a 7½ cent tax, but the period covered was only ten years. The terms of the agreement are thus summarized:

1. An export tax of 25 cents per ton for 20 years from January 1st, 1921 on all ore shipped to Nova Scotia.

2. Free exportation to all countries other than the Dominion of Canada. The companies, however, must spend three million dollars during the next five years in improvements and developments of their plants, must give notice before January 1st, 1926, of their intention to erect a smelting plant in Newfoundland capable of producing 100,000 tons of pig iron annually, and have such plant erected before January 1st, 1928, otherwise the Government will have the right to collect a maximum duty of 1 cents per ton on ore exported to parts of the world other than the province of Nova Scotia.

3. In any year that the shipments to Nova Scotia amount to a million tons, there will be no tax on the ore shipped to any other place in Canada. When shipments fall below that mark, however, the tax of 25 cents will apply to the other places.

4. All materials for construction of and for use in connection with the operation of the smelting plant are to be admitted free of duty.

5. The companies are exempted from Business Profits Tax, War Income Tax and any future tax of a similar character. They are also exempted from municipal taxation for ten years, and thereafter are not to be called upon to pay more than $10,000 annually.

6. The Government may grant the D. I. and S. Co. the Rocky river (Colinet) water powers, and the latter will pay 25 cents per horsepower developed.

7. The companies must operate smelting plant to capacity. Failure to do so will mean a tax of ten cents per ton on ore shipped elsewhere than to Canada.

8. The ore tax will be payable quarterly on the 15th of January, April, July and October in each year.

9. The companies must provide a sufficient quantity of coal to meet the requirements of the railway, including steamers and docks, the requirements of the Reid Co. generaly, and the domestic requirements of this country, at f.o.b. prices per ton "current from time to time on coal of similar quality sold for shipment to Nova Scotia ports". The companies also engage to establish a coal depot here, if the Government shall so request.

10. The companies agree to abide by any labor dispute settlement laws of this country.

11. If the Government so request the companies shall build workingmen's houses on Bell Island for their employees, on a twenty year purchase plan.

The agreement was signed in November last by the Deputy Colonial Secretary on behalf of the Government; by R. M. Wolvin, president, and C. S. Cameron, secretary, on behalf of the Dominion Iron and Steel Co., Ltd., and by D. H. McDougall, president, and A. McColl, secretary for the Nova Scotia Steel and Coal Co., Ltd.

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Beginning February, 1920, and ending January, 1921.

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Obituaries

ARMSTRONG WHITWORTH OF CANADA LIKELY TO CLOSE DOWN LONGUEUIL PLANT.

The "Montreal Star" publishes the statement that Armstrong Whitworth of Canada, Ltd., contemplate closing-down their works at Longueuil, Montreal.

Recently only their small tool shop has been operating and they have built up a large stock of all kinds of standard tools, such as, twist-drills, milling-cutters, and reamers. Their stock includes a quantity of their famous brands of high-speed and carbon tool-steels, in all the usual sizes.

Tariff Protection on Steel Tyres Withheld.

On behalf of the management it is stated that owing to the failure of the Dominion Government to give them any tariff protection on the manufacture of locomotive steel tyres they closed down their tyre mill some twelve months ago, and will not re-open their mills again, until such protection is given. Most of the raw materials they require have to be brought from the United States and are dutiable. No protection, however, is afforded them under the Dominion tariff for their finished product. This tyre mill is the only one in Canada. Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, the famous engineers and shipbuilders of England, commenced building these works in 1914, and installed all the latest machinery. Owing to the outbreak of the European war, it was difficult for them to supply the necessary technical operators from their own works in England.

About six months ago they sent D. E. Grant to go into the situation and after being in London for some weeks he has just returned to Canada.

The "Star" is informed that Armstrong, Whitworth of Canada, Limited, will carry on their agency work on behalf of the parent firm, and the firms who are allied with them, and will continue to dispose of their stock of small tools and tool steel, water turbines, dock machinery and such like, including the Armstrong Siddeley motor car.

If this business develops as they anticipate, they intend to consider seriously the establishment of such a plant in Canada. They are already discussing some large propositions for the development of Canadian resources.

SAULT STE. MARIE ASKS FOR GEOLOGICAL SURVEY OF IRON-ORE AREAS.

The City Council of Sault Ste. Marie, acting on the suggestion of the Sault Prospectors' Club has asked the Department of Mines of Ontario to make a survey of the iron-bearing district in the Northfields and Bellevue areas on the Algoma Central Railway.

The resolution of the Council urges upon the provincial government the necessity to assist the prospectors by despatching a competent geologist to look over this district, and points out that in the United States "there " is upwards of ten million feet of diamond drilling on " the Mesaba iron range alone, mostly at the expense of " the State of Minnesota, while there has been barely " 50,000 feet of drilling in the whole of Ontario, and " that done by private capital."

Similar resolutions have been forwarded to Toronto by the Rotary Club, the Board of Trade, the Independent Labour Party and the Trades and Labour Council of Sault Ste. Marie.

CANADIAN-VICKERS COMPLETE BUILDING PROGRAMME.

On May 5th., the SS. "Topdalsfjord" was launched at the Canadian-Vickers Yard, Montreal. Mr. A. R. Gilham, the Managing Director stated the Company has no further orders for ships, and that with the completion of the "Topdalsfjord", the working force of 1,400 men would be reduced to about 200 men, whom it was hoped to employ on ship-repair word. Since the beginning of 1918, Canadian-Vickers have launched over 175,000 tons of cargo shipping, in addition to a large number of trawlers, submarines and other war vessels that were built in the earlier part of the war period. The "Topdalsfjord" is one of two vessels built for the Norwegian American line. She is 365 ft. in length, 49 ft. 6 inches breadth and 29 ft. deep, with cargo capacity of 6,400 tons. Estimated speed is 11½ knots, and coal or oil can be used. The launching was unusual inasmuch as it was witnessed by a party of senators and members of Parliament who were being shown over the Harbour of Montreal by the Hon. the Minister of Marine and Fisheries.

PARLIAMENTARY DELEGATION SEE MONTREAL HARBOUR.

The Hon. the Minister of Marine and Fisheries opened the new sheds on Victoria Pier, Montreal Harbour, on May 5th, and was accompanied by a party of about 250 members of the Senate and the House of Commons, who were shown over the Port of Montreal.

The President of the Board of Harbour Commissioners, Mr. W. S. Ross, said the national port of Montreal was doing a business of seven hundred million dollars annually, handling exports and imports to the extent of fifteen million tons annually, and was now reckoned as the seventh in importance of the ports of the world. A detailed account of the equipment and business of the Port of Montreal will be found in "Iron & Steel of Canada' issue of March 1921

PORT ARTHUR SHIPBUILDING CO.

Employees of the Port Arthur Shipbuilding Company's plant have agreed to a reduction of seventeen per cent in wages, effective May 1st. according to notice placed in all shops today.

The working hours, however, have been increased from forty-eight per week, to fifty-five, which means a reduction in wages of $1.10 per week, and of skilled mechanics, approximately, $1.65 per week under the original scale.

To offset the reduction in wages, the company has agreed to grant a bonus of two and one half cents per hour, to all shop men engaged in repair work, and five cents per hour to all men of the plant actually engaged on shops under repair.

Conferences were held between officials of the company yesterday, and again this morning, at the latter conference the men intimated they would agree to the proposed changes in the working conditions, and the notices were posted in accordance therewith.

The changed conditions will necessitate the men working longer hours for the same amount of pay. However, as repair work will constitute the major part of this Summer's work, the bonus granted for this class of

work will keep the pay envelopes, on the whole, will be increased in amount.

The steamer "John H. G. Hagarty" has occupied the dry-dock since the opening of navigation, undergoing repairs to her rudder and stern frame.

The new steamers "Canadian Harvester" and "Glenafton" are just about completed, and will be ready to sail in a few days.

THE BRITISH STEEL TRADE.

The following information concerning the British steel trade has been supplied to "Iron & Steel of Canada" by F. W. Field, British Trade Commissioner at Toronto:

No appreciable amount of new business has resulted from the reductions in prices of certain classes of iron and steel material, and the reason for this may be attributed very largely to the uncertain financial outlook and to the doubt on the part of buyers that prices have not yet reached their lowest levels.

Owing to the slackness of trade a further number of blast furnaces have ceased production, and the total number now in blast on the North-East Coast has been reduced to 56 as compared with 72 a month ago.

The policy adopted by British makers in lowering their prices piecemeal has been the subject of some criticism, as it is felt in certain quarters that it has tended to encourage, rather than to prevent, the holding up of orders. Whether as a result of this criticism or not the makers of pig iron recently decided to make a strong bid for whatever business there may be waiting to be placed, and reduced their prices still further, to the extent of 45s. per ton. The new export figures for Cleveland pig iron, which came into force on 1st March, are as follows:—

No. 1 and Siliceous, 160s. per ton f.o.b.
No. 3 G.m.b., 155s. per ton f.o.b.
No. 4 Foundry, 154s. per ton f.o.b.
No. 4 Forge and Mottled, 152s. 6d. per ton f.o.b.
No. 4 White, 150s. per ton f.o.b.

Hematite pig iron has also been reduced in price to the extent of 40s. per ton, which brings the figure for East Coast mixed numbers to 180s. per ton for both home and export business. Trade in this branch of the industry has been stagnant for the last few weeks, and this reduction in price should offer inducement for buyers to come into the market.

At these figures makers are undoubtedly working at a heavy loss and have reckoned upon a big drop in fuel prices taking place in the near future. So far there has been no movement in this direction, but lower fuel prices are regarded as inevitable and the outcome of the negotiations which are now proceeding in the coal mining industry is anxiously awaited.

At present prices it takes about 70s. worth of coke to make a ton of pig iron as compared with about 16s. before the war, and a settlement of the whole fuel question is urgently necessary. In the meantime, workers in the iron and steel trade have come to realise that their co-operation is essential in the effort required to bring down cost of production, and there are good grounds for thinking that a lowering of the wages at present being paid in the industry will come about by agreement in the near future.

It is hardly likely that any further decline in pig iron prices will occur until there has been a drastic cut in production costs, and in the figures quoted above a fall in the latter has been discounted to a considerable extent.

Trade in finished iron and steel material shows some signs of improvement, although it is still far from satisfactory. Enquiries have been coming in a little more freely of late and a few orders have been placed. Prices are, however, still high as compared with those offered for Continental material, and there will have to be a big drop in fuel costs before a practicable working level can be reached.

Steel sections and plates have both been reduced in price, but very little business has so far resulted. Scottish makers are now quoting £21 for ship plates and £19 10s. for angles for home delivery, export trade being subject to negotiation. Makers of malleable bar iron have reduced their prices for bars by £2 per ton, making the price for home delivery £23 per ton, and for export £22. The North Eastern makers have lowered their prices for crown iron bars £2 per ton, bringing the price to £23. The majority of works are coming very near to the end of their orders and delivery of most classes of iron and steel material can now be given within a week or two.

The following particulars relating to the production of iron and steel during the month of February have been furnished by the National Federation of Iron and Steel Manufacturers:—

The production of pig iron in February amounted to 463,600 tons, a figure, if we except the months affected by the Railway Strike in 1919 and the Coal Strike in 1920, lower than in any month since monthly figures have been recorded. Of the total production 171,800 tons were hematite pig iron, 97,800 tons basic iron, 127,000 tons foundry, 41,200 forge, 9,300 tons ferro-alloys, and 16,500 tons "other qualities."

The production of steel ingots and castings amounted to 483,400 tons.

The following table gives the production of pig iron and steel for each month from January, 1919:—

	Pig Iron			Steel Ingots and Castings		
	1919.	1920.	1921.	1919.	1920.	1921.
February	626,000	645,000	463,600	734,000	798,000	483,500
January	661,000	665,000	642,100	718,000	754,000	493,400
March	691,000	699,000		758,0 0	840,000	
April	647,000	671,000		668,000	794,000	
May	671,000	739,000		755,000	846,000	
June	658,000	726,000		631,000	845,000	
July	641,000	750,600		618,000	789,900	
August	521,000	752,400		474,000	709,200	
September	581,000	741,000		718,000	884,700	
October	445,000	533,200		433,000	544,300	
November	624,000	403,200		695,000	505,100	
December	632,000	682,500		692,000	746,600	
Total	7,398,000	8,007,900		7,894,000	9,056,800	

The Lorain Steel Company, Johnstown, Pa., is installing a 200 K.W. Baily Electric Furnace for heat treating railroad bolts and similar parts. The furnace is of the continuous pusher type with motor operated control mechanism. It will have a capacity sufficient to heat treat fourteen tons of material per day. Installations of electric heat treating furnaces are rapidly increasing in plants which supply the railroads with equipment. Baily electric furnaces are being employed to treat such products as railway axles, draw bar knuckles, bolts, and similar castings and parts.

The Substance of Coal

Notes by the Editor.

In recent years, knowledge of the nature of coal substance has been rapidly enlarged. That coal had its origin in vegetable accumulations is now admitted, but it is less than a hundred years ago that coal was recognised to be a stratified fossil deposit, and that coal-seams could be definitely related to certain named geological periods. With the adaptation of the microscope to the examination of thin coal-sections, thereby revealing the structure of coal substance; and the turning of the attention of botanists to study of the plant remains found in coal substance, and associated with the strata in which coal is usually found, much light has been thrown on the character of the vegetation from which coal has been formed. Later, the researches of the chemist have afforded information of the process of decay and the progressive carbonization of this vegetable matter. The bacteriologist has added his quota of knowledge to that of the microscopist, the paleobotanist and the chemist, and it is being recognised that coal is a much more complex substance than was suspected, and that its economic possibilities have in the past gone unrealised by reason of wasteful and incomplete methods of combustion.

Dr. Reinhardt Thiessen, Research Chemist of the U. S. Bureau of Mines, read a paper before the Coal Mining Institute of America in Pittsburg in December 1920, from which most of the information contained in this summary is digested, and from which the illustrations have been taken.*

Banded Bituminous Coal.

The banded and striped appearance of bituminous coal is well-known and these alternating layers of bright and dull coal are divided by microscopists into two substances, known as "bright coal" or anthraxylon, and "dull coal" or attritus. The bright coal is the fossilised remains of wood of various sizes, and the dull coal is composed of the macerated debris of vegetable accumulations that have undergone putrefaction and very complete decay, and is best represented in modern examples by the black jelly that forms in the bottom of peat bogs. (see Figs. 1 and 2).

The Constitutents of Bright and Dull Bands.

Dr. Lessing, in conjunction with Dr. Marie C. Stopes, has found that the constitutents of banded bituminous coal can be microscopically recognised and largely separated by a combination of chemical and mechanical means. (See "Studies in the Distribution of Mineral Matter in Coal". Trans. Inst. of Min. Eng. vol. lx. p. 288, 1921). Dr. Stopes separates bituminous coal into four chief ingredients which she has named fusain, durain, clarain and vitrain. As a result of Dr. Lessing's

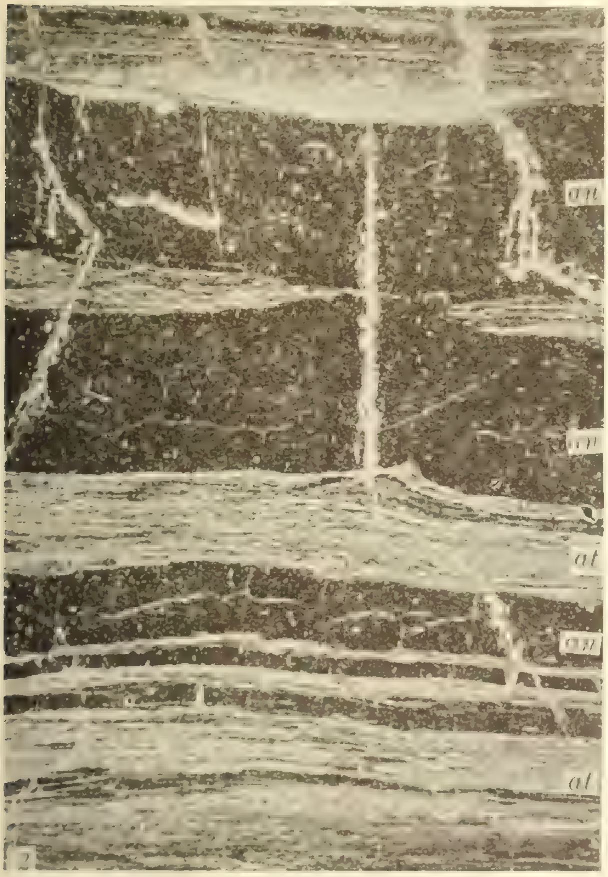
* For full text of this paper and illustrations, see Canadian Mining Journal, issues 4, 5, 6, 7—1921

A BLOCK OF ILLINOIS COAL.

Fig. 1.—The dark ... [illegible] ... twee the anthraxylon bands ... [illegible] ... The white lines ... [illegible] ... filling narrow vertical crevices in the coal. Some of these plates are seen exposed on their [illegible] side. Natural size.

investigations into coal-washing, he believes "it is a fallacy to regard the ash in coal merely from a quantitative point of view as a certain amount of inert matter". Dr. Lessing believes that the ash in coal, and its quality, has a good deal to do with its action in burning, or what he terms "thermal decomposition". The constitutents of banded bituminous coal, as investigated by Lessing, Stopes, Tideswell and Wheeler, are classified as follows:

(a) *Fusain.* The equivalent of "mother-of-coal, or mineral charcoal.
(b) *Durain.* Dull hard coal.
(c) *Clarain.* Bright portion of coal still containing recognisable plant remains.
(d) *Vitrain.* Bright coal of conchoidal fracture without recognisable structure.

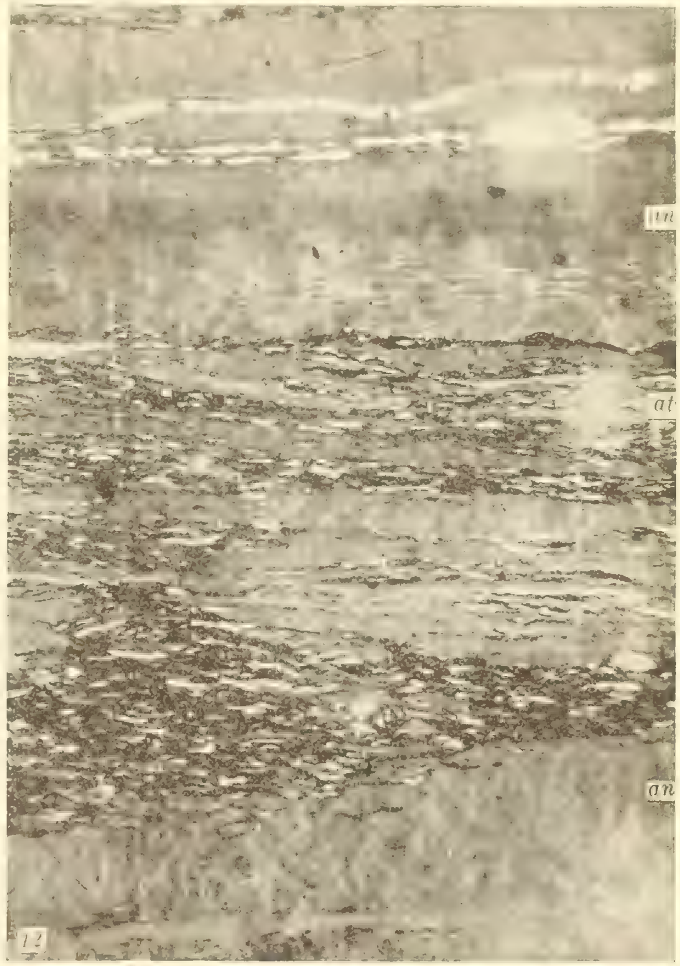


2.—A part of a vertical cleavage face of coal magnified ten diameters, photographed by reflected light. The black bands (an) represent anthraxylon, the light striated bands (d) represent the dull coal. It will be noticed that the latter is compiled of black and light striae; the former represent anthraxylon and the latter attritus.

The average quantity of ash contained in the four ingredients was determined to be in the samples examined:

Fusain	15.59 per cent
Durain.	6.26
Clarain	1.22
Vitrain.	1.11

Dr. Lessing suggests that advantage should be taken in coal-washing of this determined distribution of ash in certain now recognisable ingredients of coal. For example, the dust in slack-coal going to the washer has been found to consist largely of fusain, which not only contains a high amount of ash, but is entirely devoid of coking properties. It is believed that the saving of the fines and their reincorporation with the washed coal may really be undesirable. For example, it is stated by Dr. Lessing, that "the quantity of dust going forward with coking slack averages five per cent of the total. The ash-content amounts to as much, or more, and possibly double the ash-content in all the clean coal making up the bulk of the washed slack. The removal of dust, prior to washing seems very desirable, for coking purposes, on Dr. Lessing's showings. Another matter that Dr. Lessing's researches throw light upon is the fusibility of ash in coal, a matter of great importance to Canada in regard to lignite and sub-bituminous coal uses. The segregation of the pyrites in coal, their removal to reduce the sulphur-content of coke made from given coals, and their possible concentration as a by-product of coal-washing, are questions to which a solution is suggested by Dr. Lessing's work.



12.—Thin vertical section of coal from the lower Freeport seam, showing thin bands of anthraxylon (an) and attritus (at).

It is suggested by the investigators above-mentioned that it is possible to separate any coking slack into two or more fractions, namely:

a. An almost ash and sulphur-free fraction for the production of a superior coke. This fraction varies from 55 to 76 percent of the whole sample. Its coke would yield 3 percent of ash and well under 1 percent of sulphur.
b. A homogenous coaly substance, suited for low-temperature distillation, yielding a "coalite". The weight of this fraction varies from 17 to 34 percent of the weight of the coking slack; it would yield a coalite containing from 7 to 12 per cent of ash and in addition much yield in byproducts.

(e) A fraction of the whole weight of unwashed material 20 to 26 per cent, which contains about 55 to 60 per cent of dirt to be treated in a shale retort.

Dr. Thiessen, commenting on these results, points out that there is in coal an inherent ash, and also an inherent sulphur which cannot be eliminated by ordinary washing-methods. Pyrite is disseminated throughout coal in microscopic particles, as shown by microphotograph 26 shown accompanying. Dr. Thiessen asserts that the "bright coal" always gives a better coke than the "dull coal" of the same coal. Even when coals are classed as non-coking, the "bright coal" of such coals will give a fairly good coke, but the "dull coal" will not. The microscopic particles of sulphur are chiefly to be found in the "bright coal."

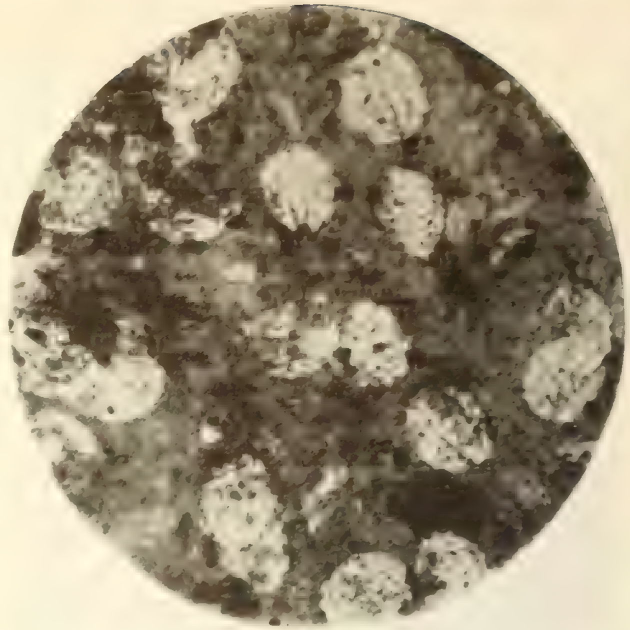
26

Thin cross section of anthraxylon of coal from Middle Fork, Illinois, No. 6 bed, showing finely disseminated pyrite particles. Magnification 200.

The lessening quantity of low sulphur coking coal suitable for metallurgical purposes is giving some steel companies cause for anxiety, and it would seem that those in charge of the provision and preparation of coal for making coke, and for steel-plant uses might with advantage devote time to investigation of the later developments of the study of coal substance.

Spores in Coal.

Dr. Thiessen has paid great attention to the collection of photographs of distinctive spores found in coal. He has found that certain ornamentations and shapes of spore-exines are characteristic of certain coal-seams, and that the correlation of coal seams can be definitely established by the presence of typical spore-exines. A number of Dr. Thiessen's microphotographs are herewith reproduced, from which the wonderful preservation of outer walls of the spore-cases, or exines is observable. Apart from many other interesting phases of this fascinating study, the economic value of a definite means of correlation of coal-seams is obvious.



Horizontal section of Pittsburg coal at a high magnification to show the broad [illegible] characters of spore-exines and other constituents in detail. Magnification 1000.

Some eight years ago Mr. James Lomax, an English coal-microscopist, examined a number of the Cape Breton coals by means of thin sections. He found the same distribution of microscopic particles of pyrites referred to by Dr. Theissen, and mentioned that, compared with English coals, the Cape Breton coals were not marked by the presence of so many spores. The spores present are stated to be thin-walled and apparently of a primitive variety. One interesting feature of thin sections of coal is that the general colour of thin sections, when held up to the light, and not viewed microscopically is sufficient to give a trained observer some idea of the quality of the coal being examined and

Part of horizontal section of Brookville coal including spore-exine with peculiar processes. Magnification 1000.

Broad-side view of megaspore-exines of the Buxton coal. These spore-exines in the coal have each three long delicate wings or air sacks, but these were broken in recovering them from the coal. Magnification 30.

Cross section of the same kind of spore-exine shown in Photograph above showing one of the three wings in cross section. Magnfication 100.

its usefulness for certain purposes. Nova Scotia coals are marked by a preponderance of cuticle matter and a characteristic reddish tinge, and it is possible to pick out a gas coal from a steam coal by the colour as shown in thin section.

The Toronto Iron Works, Limited, Cherry Street, Toronto, have been fairly busy for some time and are now running on full time. They have a number of orders ahead for iron tanks in which the firm specializes.

SALE OF ATIKOKAN BLAST FURNACE AT PORT ARTHUR, ONT.

J. J. O'CONNOR.

News of the sale of the Atikokan Iron Company's blast furnace, at Port Arthur, has been received with the greatest satisfaction. It has long been felt that the fact of this furnace lying idle has been one of the greatest handicaps the iron-ore resources of Northern Ontario had to contend with in interesting capital in their development.

Now that this furnace is to be put in blast, the operation of local iron-deposits is assured, and the building up of a permanent iron-ore and pig-iron industry, together with all the collateral lines of endeavour that naturally follow such an industry, are within the grasp of this community.

Mr. J. Dix Fraser, Superintendent of the Atikokan Iron Company, arrived here on the 16th. accompanied by John E. Hogan, of Chicago. They met the Finance Committee of the City Council on the 18th. and laid the proposed agreement of sale before that body, asking for ratification thereof by the City Council. In a special session of the City Council held on the 19th. called for this purpose, a resolution of the Finance Committee recommending the sale of the Atikokan Iron Company's blast furnace at Port Arthur, was duly ratified, the consent of the City of Port Arthur being necessary owing to the fact that the City has a substantial monetary interest in the property.

The name of the purchasers of the blast furnace is withheld for financial reasons, for the present. Mayor Matthews is in possession of this information, and is eminently well satisfied with their bonafides, financial strength, and experience to carry out such an undertaking.

The new undertaking involves the development of iron ore deposits in Minnesota, adjacent to the International boundary, the construction of a few miles of railway to connect with Port Arthur, Duluth & Western Division of the Canadian National Railway, at, or near Gunflint Lake, and the heavy placing of this division in a condition to accommodate heavy traffic. Mr. Hogan has left for Toronto to consult with Mr. D. B. Hanna, President of the Canadian National Railway, pursuant to the carrying out of the necessary connections and betterments.

It is the intention of the City Council to submit a By-Law to the electors in the near future, to fix the assessment of the blast furnace under an agreement, for a fixed number of years.

GOVERNMENT WILL SEND PARTY TO BELCHER ISLANDS.

It is understood that the Dominion Government will send a party to the Belcher Islands, Hudson Bay, this summer to examine thoroughly the iron ore deposits there. It is known that very important deposits have been discovered and that these may form the basis of an iron-mining industry in the far North. Private reports are said to state that large bodies of ore of good grade have been located. It will probably be a part of the work of the men sent north this summer to examine into and report on the methods of getting the ore to market.

RESERVOIR FOR COMPRESSED-AIR SYSTEMS IN WORKS AND FACTORIES.

JOHN S. WATTS, New Glasgow.

The convenience of compressed-air, as a system for transmitting energy, suffers from its inability to carry an overload, for any longer than two or three minutes. That is, to put the case the other way round, a compressor must be installed of sufficient capacity to carry the peak load indefinitely, even although this peak load may only recur at long intervals, and continue for only short periods of time.

Nearly all other engineering apparatus can carry an overload for a reasonable period of time, that is a load which would be too great for the apparatus, if continuous. For instance, electric motors will carry up to one hundred per cent overload for a time, steam boilers have a reserve capacity of energy in the water contained in them, and can also by forced firing be made to carry a fifty per cent overload for some time.

Where the demand for compressed-air fluctuates to any considerable degree, this necessity to have a compressor large enough to carry the peak load, compels the installation of a very large compressor, being possibly twice as large as would be needed, if the load could be averaged, thus making the capital expenditure on the compressor very high, bearing in mind that it will be running idle perhaps one half or more of the day.

This fluctuation in demand for air, coming directly on the compressor causes it to be dropping its load and picking it up again frequently, and this sudden loading and unloading throws severe racking strains on the compressor, and makes for a high upkeep cost.

The evident remedy for this state of affairs, is to have a reservoir of compressed air, which can be filled with compressed air, during periods of low demand, and which will give out its supply during the period of peak load.

The air receivers used, cannot fill this function, as they can only supply air to the system to the amount of about one-seventh of the capacity of the receiver, this being the amount the air will expand while the pressure falls from the highest to the lowest useful pressure, say from one hundred pounds to eighty pounds.

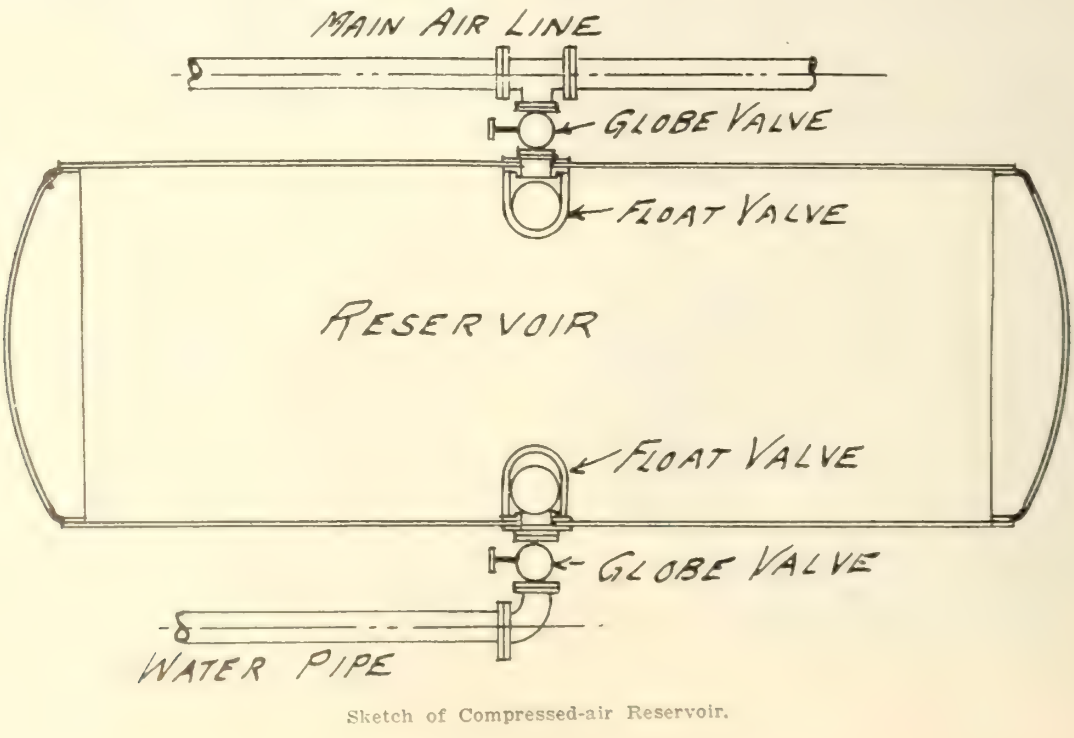
Up to date, there have been only a few compressed-air systems, supplied with a reservoir, and these have been in mines where old workings where available for air storage. These have been a success, and it would appear that the time is ripe for an extension of this idea to factories and plants using compressed air.

The obvious form that such a reservoir for a factory would assume, would be similar to that of an hydraulic accumulator, but the diameter of the plunger to get the desired capacity would need to be much larger than those commonly used for hydraulic work, and rather expensive to be installed, unless there were no other alternative.

Fortunately in most cases, we have a cheaper arrangement available, which needs only for its operation a water supply at a pressure not less than the lowest usable pressure on the air system. This minimum pressure is generally eighty pounds, and as in most towns the water pressure is that much more, we have a very convenient supply.

A very cheap and efficient reservoir then, can be made by installing a tank, and connecting it up to the air piping as indicated in the accompanying drawing, a connection being made into the top of the tank from the main air-pipe, and into the bottom of the tank from the water service. Both of these connections are fitted with float-actuated valves, inside of the tank, the upper one closing whenever the tank is filled with water, and the lower one whenever the water is forced out of the tank. For convenience it is advisable to fit a globe valve in each of these connections outside of the tank, to permit of isolating the tank for cleaning, etc., without interfering with the working of the air compressor.

The operation of the reservoir is as follows. When pressure is off the air-line, before the compressor starts, the tank will fill with water at say eighty



Sketch of Compressed-air Reservoir.

pounds pressure, until the rising water closes the upper float-valve, which prevents any water entering into the airlines. The compressor being started, will, whenever its output exceeds the demand for air, force the pressure above eighty pounds, and so force the water out of the tank, and back into the water main, until the tank is empty, when the lower float-valve will close, and prevent the air entering the water pipes. Assuming that the compressor still delivers more air than is being used, the air pressure will continue to rise until, say, one hundred pounds is reached, when the unloading valve on the compressor will stop further compression of air and the compressor will run idle, until the pressure falls again.

Whenever the demand exceeds the supply from the compressor, the pressure in the reservoir will commence to fall, and the air expanding in the reservoir, will furnish a supply of air, equal to about one-seventh of its cubic capacity, until the air pressure falls to the minimum of eighty pounds. At this stage the water will commence to enter the reservoir, the air-pressure and water-pressure being then equal, and thus force out the air contained in the reservoir to meet the increased demand, until such time as the demand falls to less than the delivery from the compressor.

A small amount of oil may be carried over with the air into this reservoir, but as this all floats on top of the water, it does not contaminate that body of water which is forced back into the water pipes, and if the tank is cleaned out occasionally will do no harm, although it is as well to connect the water from a part of the piping that is remote from any drinking fountains. The tank should have a manhole for the purpose of cleaning and inspection.

A water-gauge, fitted to one end of the tank, affords the operator means of knowing how the air compressor is holding up to its work, and its provision is well worth while.

When the water service is at a pressure of over one hundred pounds, a reducing value can be fitted to bring the pressure down to the minimum air-pressure desired.

When the water pressure available is less than the minimum useful air-pressure, the same effect can be had by placing the reservoir at the lowest elevation available, and installing a water tank of the required capacity, at a height that will give the desired minimum pressure. This tank can be used for other purposes, such as fire protection, without interfering with the efficiency of its purpose in connection with the reservoir.

CANADIAN ENGINEERING STANDARDS ASSOCIATION.

A Meeting of the Main Committee of the Canadian Engineering Standards Association was held at Ottawa on April 4th, Sir John Kennedy in the Chair, and the following were some of the more important matters dealt with:

Sir John Kennedy was re-elected Chairman; Mr. T. A. Russell and Mr. H. H. Vaughan were re-elected Vice-Chairman, and Dr. J. B. Porter was re-elected Honorary Secretary Treasurer.

The following gentlemen were welcomed as members of the Main Committee:

Mr J. B. Reade, Purchasing Commission of Canada; Mr G. A. Mountain, Board of Railway Commissioners for Canada; Lt.-Col. E. W. Stedman, The Air Board; Dr. L. V. King, McGill University; Mr. T. F. Sutherland, Canadian Institute of Mining and Metallurgy.

A large number of additions to the membership of various sectional and sub-committees were approved, and thirty gentlemen, members of various working committees, were elected to membership in the Association.

The Annual Report and Financial Statement to be issued to members of the Association, were presented and approved.

The attendance of Mr. R. J. Durley, Secretary, at the Conference of Secretaries of national standardizing bodies in London on April 25th was approved. This Conference is of an informal nature and is intended to facilitate the interchange of information and data regarding standardization, especially in its international aspect, and with regard to planning the methods of intercourse and co-operation to be adopted between the various national standardizing bodies. It is expected that the meeting will be attended by delegates from Belgium, Great Britain, Canada, France, Holland, Italy, Sweden, Switzerland, and the United States. Each Secretary will naturally present a report on the work of the Conference to his Committee or Council on his return.

The activities of the Association during the past year and the present state of the work of the various committees are briefly covered by the attached report.

Among the subjects on which the Association has recently been requested to take action may be mentioned the following:

A request from the Air Board has been made for the preparation of specifications for certain aircraft materials which cannot be obtained under commercial conditions in Canada, the wartime specifications of the British Air Board being much too elaborate for use under peace conditions. The necessary committees are being arranged for.

Co-operation with the American Engineering Standards Committee has been requested in connection with the Aeronautical Safety Code, the American Safety Code for Logging and Sawmill Machinery, and the American Committee which is considering the standardization of parts of elevator machinery.

Requests for co-operation have also been received from the Canadian Electric Railway Association and the American Gear Manufacturers Association.

In connection with this work of the Sub-Committee on Portland Cement, which is engaged in revising and re-drafting the Specification for that material originally issued by the Canadian Society of Civil Engineers, the Main Committee approved of the suggestion of the Sub-Committee as to the desirability of experimental work on Canadian cements with regard to the best method of determining normal consistency. The Main Committee also directed that arrangements should, if possible, be made with the proper authorities for the standardization of cement sieves in Canada.

The meeting terminated with a vote of thanks to the Executive Committee and the Officers and staff of the Association.

The meeting of the Main Committee was followed by the Third Ordinary General Meeting of the Association, which was largely of a formal nature and during which the Annual Report and Financial Statement were presented and approved.

Froth Flotation as Applied to the Washing of Industrial Coal

By ERNEST BURY, WALTER BROADBRIDGE and
ALFRED HUTCHINSON

(A paper read before the Institution of Mining Engineers, Manchester, September 15th, 1920.)

Introduction.—In the autumn of 1919 Sir Arthur F. Pease suggested to the Skinningrove Iron Company that the froth-flotation methods, as practised by Minerals Separation, Limited, for the recovery of fine metalliferous ores from slimes, should be investigated as a possible means for the separation of fine coal from shale and other impurities. The authors accordingly erected at the works of the Skinningrove Iron Company several small washers working under Minerals Separation patents for the experimental separation of crushed coking coals, washery wastes, fine coal sludges and the like. The object of this paper is to indicate to the members of the Institution the results of the experiments so obtained, and to suggest the importance of this method of treatment to the fuel and metallurgical industries as a whole. The paper will include a short description of the principles of froth flotation, followed by a somewhat detailed account of the operation of the froth-flotation process, and a few remarks on the application of the process to coal treatment in general. Representative results obtained on various types of material will then be included, and the paper will conclude by indicating the economic aspects of the process, especially as applied to the preparation of coal for the production of metallurgical coke.

Principle of Froth Flotation.—When certain reagents are added in small quantities to water, and the whole is agitated violently, a multitude of very minute air-bubbles are formed. On allowing the liquid to come to rest, the bubbles do not coalesce, but remain distinct from each other, and rise slowly to the surface, where a more or less permanent froth is formed. The reagents that may be used for this purpose are many and various, and include certain oils (such as turpentine), soluble organic substances (such as cresol), certain alcohols (such as amyl alcohol), and soaps. The proportion of reagent required is small, amounting in most cases to a fraction of a pound of reagent to a ton of water.

If solid particles are suspended in the water, these particles may or may not become attached to the bubbles; if they do so, on allowing the liquid to come to rest, the bubbles rise to the surface and form an extremely stable froth, in which the solid particles are supported. Particles of metallic sulphide, coal, and graphite can be readily floated by this method; on the other hand, sand, clay, and similar earthy materials do not adhere to the bubbles, and therefore sink to the bottom of the liquid. It follows that, if a mixture of floatable and unfloatable particles in water is subjected to agitation in the presence of a suitable frothing agent, the floatable particles will be included in the froth, while the earthy matter will sink to the bottom. Thus, if coal containing a proportion of clay or similar material is ground to pass a 1/10 inch screen, and the product is mixed with water to which a suitable reagent is added in small quantities, the coal can be separated in a pure state from the clay. If the coal comprises pure coal, carboniferous shale, and clay, the pure coal can be recovered in a pure state, after which, by adding a small quantity of oily reagent, the carboniferous shale can be recovered, the clay being finally left behind.

It should be noted that the froth-flotation process does not depend on the specific gravity of the substance, since some substances (such as galena), which are most readily floated, possess a high specific gravity.

Operation of Froth-flotation Process.—The operation of the froth-flotation process is broadly similar for all types of material treated, and involves the three stages of (1) crushing, (2) flotation, and (3) disposal of products. The details of best practice vary, of course, with the material treated and the type of product required, and the treatment of coal will differ somewhat from that of metallic ores. As the process is now estimated to treat 70,000,000 tons per annum, we can expect considerable help from this sister branch of the industry in rapidly developing the best methods to employ on coal treatment. We have made ourselves conversant with the methods employed in metallurgical practice, and have investigated the question of applying them to coal treatment.

Taking the three stages in their natural order, we wish to explain our conclusions as follows:—

(1) **Crushing.**—As it is already standard practice to crush coal for bye-product coaking, flotation introduces nothing of a revolutionary character in this respect. The material should be crushed to a degree sufficient to ensure—

(a) That the largest particle of floatable material is sufficiently small to be held in the froth; and

(b) That the floatable material is freed sufficiently from adhering waste for efficient separation to be possible.

In cases where the valuable material and the waste occur distinctly separate as large crystals or broad bands, (a) will be the deciding factor; whereas fine and intimately-associated crystallization or narrow stratification render (b) most decisive. The process treats the finest as well as the coarsest floatable material, and no classification of the crushed material is necessary or advisable.

As a result of investigation, it has been established that the most suitable crushing for coal is for it to pass a screen of 1/10-inch aperture.

In ore-dressing, the practice now generally employed is to crush everything smaller than about 1½ inches in a watery pulp. For coal-crushing we advise that the material be kept dry throughout.

In metallurgical practice, the use of screens is avoided as much as possible, their place being taken by classifiers; for coal treatment we believe that the use of screens is advisable.

These variations from metallurgical practice are rendered advisable simply because coal is a "light" material, whereas metallic minerals are "heavy." Unfortunately, rolls, ball-mills, and the like do not grind to the required degree in the first operation with the guarantee that no oversize will be produced, and control by screen or classifier is necessary. Efficient wet-

screening entails the use of large quantities of water, which in turn requires the introduction of dewatering tanks; the only alternative is water classification.

As the shale is of greater specific gravity than coal, control by classifier results in the shale being crushed to a finer degree than the coal. This is economically undesirable: crushing costs money, and shale is the hardest constituent to crush. In this connection it is interesting to note that the work at Skinningrove proved that the ash is largely concentrated in the oversize, as the figures in Table I. demonstrate:—

Table I.—Coal Received from Crusher and Screened on a 1/8-inch Screen.

No	Ash in total coal. Per cent.	Percentage through screen.	Ash in undersize. Per cent.	Ash in oversize. Per cent.
1	18.2	77.8	10.6	44.5
2	13.0	71.4	7.7	26.2
3	13.5	73.7	8.7	37.0

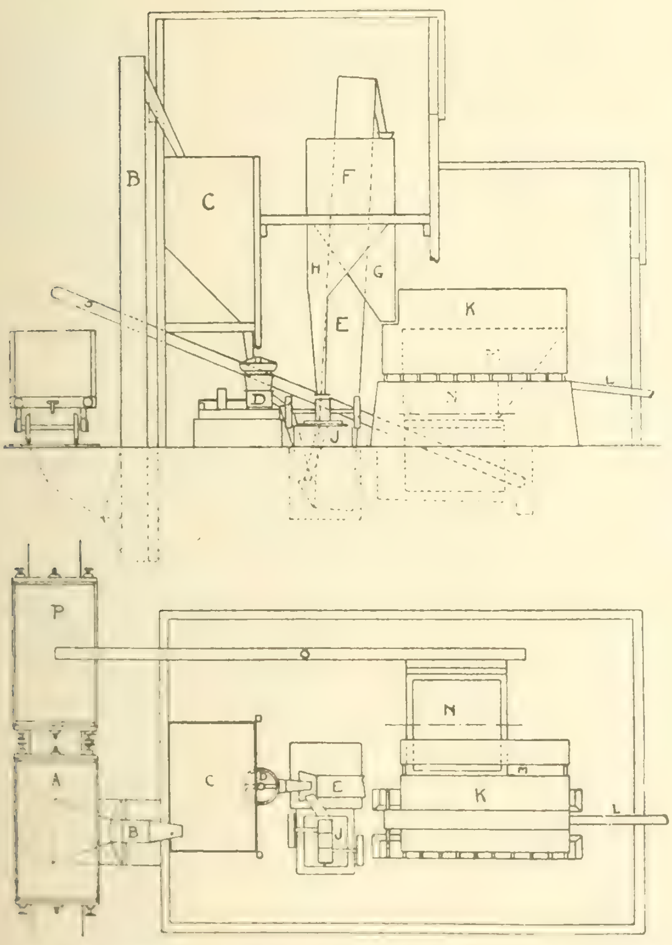


Fig. 1.—Diagram of Testing Plant at the Powell-Duffryn Colliery, Aberdare.

In such a case it may be decided to pass the undersize direct to the ovens without further treatment, leaving only the oversize for the flotation process, although, in view of the still better quality of the flotation product, the wisdom of this course is questionable.

Once the general principles are decided, it is not difficult to suggest a flow-sheet for crushing to flotation size. Our own idea is to crush in gyratory, jaw, or sledge-mills to about ½-inch, screens through vibrating screens of 1/10-inch aperture, pass the oversize through crushing-rolls, and return the product to the screens; the undersize from the screens to pass to the fine storage-bins, and thence to the flotation plant, the washed coal passing to the dryers. Fig. 1 illustrates a testing plant on these lines now operating at the Powell-Duffryn Colliery, Aberdare, whilst Fig. 2 is the flow-sheet relating to the plant.

We believe this method to be both efficient and economical, inasmuch as the material is crushed just fine enough for the purpose, and no finer.

That the product obtained approaches this ideal is indicated by the screen analysis of flotation product made from coal thus treated shown in Table II.

Table II.—Screen Analysis of Coal Concentrates from Oliver Filter, Skinningrove.

Mesh on	Under	Weight percentage Direct	Cumulative	Ash percentage Direct	Cumulative
As produced		100	—	3.5	—
20	10	58.0	58.6	2.7	2.3
40	20	8.3	63.9	3.2	2.76
60	40	5.3	72.2	4.0	2.85
100	60	5.3	77.5	4.5	2.96
150	100	5.3	80.0	4.8	3.03
200	150	2.6	83.4	5.4	3.11
	200	14.0	97.4	5.9	3.51

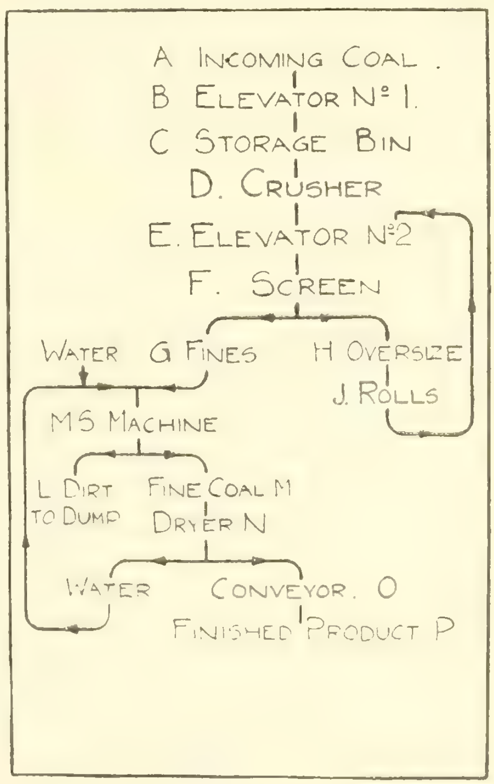


Fig. 2.—Flow-sheet of plant shown in Fig. 1.

(2) **Flotation.**—Concerning the actual operation of the flotation process, nothing is more remarkable than its extreme simplicity in practice, once the proper reagents have been found. Given a steady flow of pulp of suitable water-solid ratio, and a regular feed of reagent, a modern flotation machine will produce a clean product on the one hand and a remarkably value-free residue on the other, in fashion automatic, regular, and persistent. So simple is the process that a large number of different machines have been designed and worked with success in the metallurgical field. Very few, however, are of universal application; and after a close study of their points of advantage and disadvantage, and after practical tests on the subject, we

have come to the conclusion that the type known as the "M.S. Standard" is the one best adapted to the treatment of coal. The machine is usually constructed largely of wood, although other materials, such as sheet-iron or concrete, can be substituted. It is designed to alternately subject the coal-water pulp and reagents to sufficiently violent agitation to entrain air, and then bring it to a state of comparative rest. During agitation the air-bubbles collect and attach themselves to coal-particles, and when the pulp is brought to rest the air-bubbles, heavily charged with their collected load of coal, rise to the surface to form a thick, heavy, stable froth, whilst the remainder of the pulp continues in circuit for retreatment. The machine is a combination of a number of sets consisting of an "agitation-cell" and a "froth-box" placed in series side by side so that the sets have a common wall and the vertical agitators are all in line. Agitation box No. 1 is connected by a slot through the common wall to "froth-box" No. 1, and this is connected by a pipe to "agitation cell" No. 2, the said pipe connecting the bottom of the "froth box" with the centre of the bottom of the "agitation cell." The pulp passes from mixing cell to frothing-box, and from frothing box to the next mixing cell, until all the coal has been removed from the froth. The number of sets required depends upon the character of the coal, four or five being sufficient in most cases. It may be advisable in certain circumstances to add one or two mixing cells, without corresponding froth-boxes, at the head of the plant, the flow in that case being from mixing box to mixing box through slots in the common wall.

The accompanying photograph (Fig. 3) shows an 8-mixing-cell 8-froth-box plant; whilst Fig. 4 illustrates the flow of the pulp through the machine.

The crushed coal and water in proportions of 4 to 5 parts by weight of water to one part of coal, are fed into the first cell, where is also added the necessary proportion of reagent. This proportion is of the order of half-a-pound to each ton of dry coal treated, and varies slightly from this according to the particular material. At Skinningrove it has been found that the water used for washing the naphtalene from coke-oven gas is, after the separation by settlement of all the naphtalene, still sufficiently rich in suitable reagents to treat all the coal required for the coke-ovens; in other words, the production of high-grade coke-oven coal will cost nothing for reagents.

The coal-water mixture, which we technically term "pulp," then circulates, as previously mentioned, in what may be described as a horizontal spiral curve, discharging washed coal at each forward bend. Such discharges may be taken off individually or combined into one, two, or more qualities, according to requirements. By proper adjustment of the quality and quantity of reagents, the low-ash, high-grade coal is thus early separated from the bone-coal (high fixed ash) and the shale or clay. When this point is reached, as is readily determined in practice, a small quantity of paraffin or similar oil is added to the appropriate mixing cell in the proportion of about one-third pound to each ton of dry original coal. By this addition, the bone-coal, which has hitherto remained with the shale or clay, is induced to float, and is removed as a separate product. Such bone-coals obtained in practice contained from 2 to 15 cent. of ash.

The tailings or residues run to waste from the last froth-box consist of clay, shale, or other gangue material with which the coal was originally contaminated, and have an "ash" content varying from 60 to 85 per cent., according to the nature of the gangue.

(3) **Disposal of Products.**—In the treatment of a coking coal, therefore, three separate products result, namely, the "tailings," the "high-grade coking coal," and the "bone-coal."

(a) **Tailings.**—The tailings in some cases may be of no value, but may in others consist of high-grade fire-clay, in which case recovery might be worth consideration. The proportion of water to solids will be approximately 30 to 1 in the treatment of a coking coal, and the pulp readily flows by gravity to any convenient dumping-ground, where the shale rapidly settles out, leaving the clear water, which is quite inocuous, to pass to the drains.

Where the water is scarce and re-use desirable, the tailings may pass to a continuous-discharge Dorr Thickener, or similar contrivance, which delivers a clear overflow to the pumps, and discharges a thick pulp at the outlet-valve.

(b) **High-grade Coking Coal and Bone-coal.**—Either washed product, which forms as a thick, stable, heavy scum on the water surface in the froth-boxes, is made to overflow gently, as formed, by the aid of revolving paddles, which move it slightly forward at each revolution they make. As discharged from the lip of the froth-box, the product contains about 50 per cent. of moisture. The further draining or drying of this material in the most economical and efficient way is a problem to which we are now paying close attention.

In metalliferous ore-dressing practice, the concen-

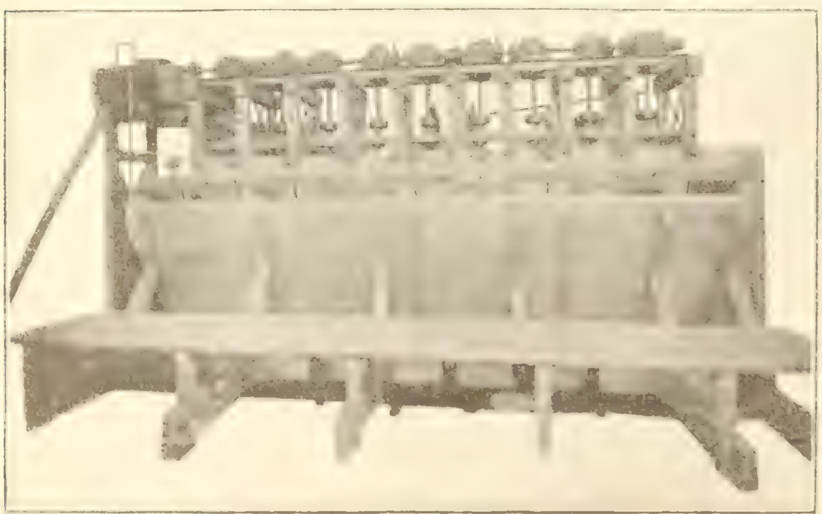


Fig. 3.—Photograph of an 8-mixing-cell 8 Froth-box Plant.

trate is washed into thickening tanks, discharged into revolving filters of the Oliver type, drained under suction, and discharged as a filter cake containing from 10 to 15 per cent. of moisture. Further drying by heat is part of the smelting process, and does not adversely affect the value of the product.

We have applied this type of treatment with success to coal concentrates, and, by suitable arrangement of the plant, have succeeded in discharging the concentrate directly into the filter, and have thus discarded the thickening process.

Already we have succeeded in reducing the moisture from 50 to 10 per cent., a figure which is comparable with the moisture content in crushed coking coal treated by gravity washers. We consider, however, that this degree of draining from either type of washer is inadequate, average coking practice being deficient in this particular.

An alternative method of mechanical drainage is to employ continuous centrifugal driers, and we are informed that there is such a machine on the market guaranteed to give a product containing 8 and possibly only 7 per cent. of moisture.

It is fully realized in this connexion that there is a limit beyond which the removal of water, as water, is practically impossible, as thin films of water are very persistent. The removal of further moisture beyond this limit necessitates evaporation.

Whether it would be profitable to approach this limit too closely by mechanical means is a question we hope to settle in the near future. In order to supplement these means, or even replace them, we have the possibility of utilizing waste-heat in many ways. Obviously, by proper application, any degree of dryness can be produced, but careful consideration to all proposed methods must be given, because dusting, with its attendant loses and explosion risks, and also overheating, must be avoided. Another disadvantage of such methods lies in the inevitably bulky nature of the apparatus.

Scope of the Flotation Process in Coal-washing.—So far we have discussed the question of coal flotation chiefly from the point of view of its application to the production of blast-furnace coke. The same process, however, with little or no modification, is equally applicable to the treatment of (1) low-grade coals for fuel purposes, (2) washery waste, (3) dump waste, (4) stock duff, and (5) slurry or other coal-bearing material.

The application of the process to the treatment of such materials is now well established, the results shown in Table III. having been obtained from waste material (Powell-Duffryn Aberaman tip):—

Table III.—Results obtained from Waste Material.

Product.	Weight. Percentage.	Ash. Percentage.	B.Th.units per pound.
(1) Raw coal	100	70.4	2,280
Washed product. .	15	15.6	12,450
(2) Raw coal	100	67.6	5,230
Washed product. .	21	10.5	12,280
(3) Raw coal	100	48.5	4,390
Washed product. .	30	10.5	12,680

The chief difference between treatment of high-grade coal and low-grade waste lies in the different proportions of product to waste — a factor which is readily allowed for in designing the plant. In our experiments we have succeeded in obtaining perfect separation of coal from shales and other impurities, in whatever proportions the minerals may be mixed, and we have met with equal success in the treatment of all types of material as above-mentioned. These include the finest coal-dust found on colliery roads, at pitheads, and in the slurry ponds to which the fine untreatable discard of gravity washers is led.

Arguing from general principles, it might be maintained that the presence of pyrites in a coal would bar its treatment by flotation, since pyrites is one of the metallic minerals readily concentrated by the process. As a matter of fact, however, the reagents employed to treat coal are of a different character from those

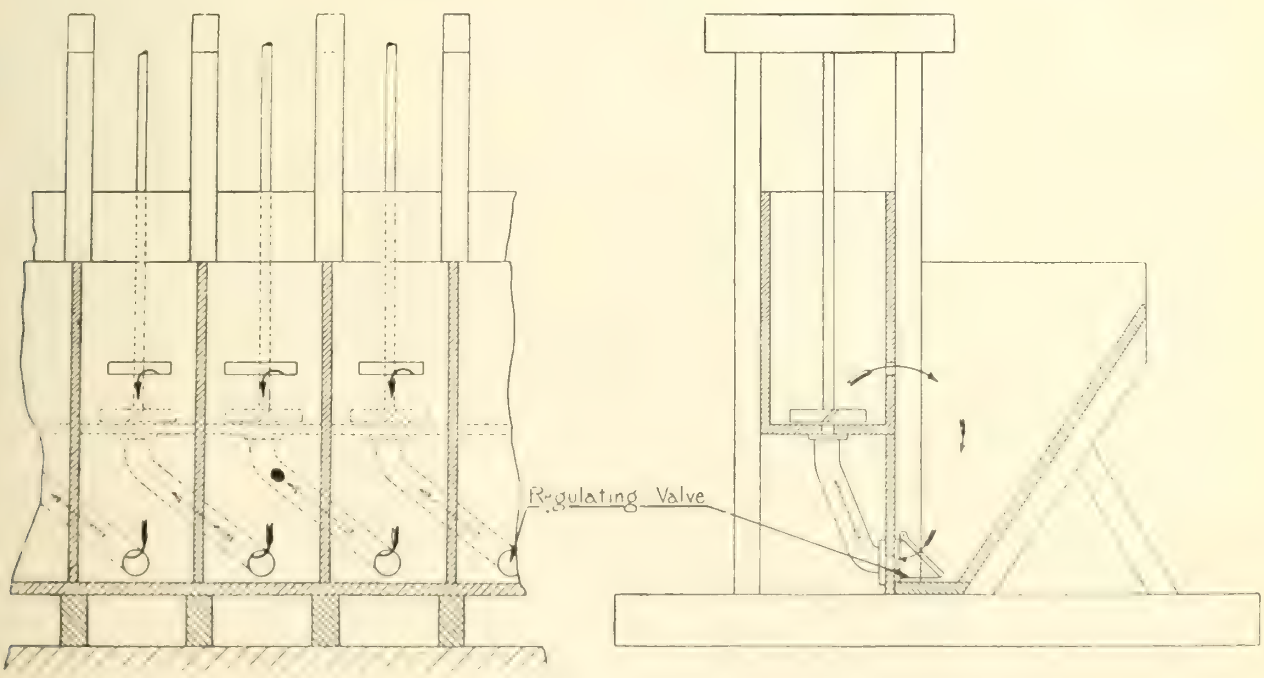


Fig. 4.—Diagram illustrating the Flow of the Pulp through the machine.

[illegible] and it is found that in the treatment of pyritic coal the coal floats for preference, with the result that the product obtained contains less sulphur in proportion than the raw material. Gypsum and other sulphates are, practically speaking, totally eliminated by the process.

Table IV.—Results of Tests.

Original		First product		Second product		Third product		First and second products together		Tailings	
No.	Ash	Weight	Ash	Weight	Ash	Weight	Ash	Weight	Ash	Weight	Ash
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
					CRUDE COALS. A—*Coking.*						
1	12·4	78·6	3·1	9·2	10·1	—	—	87·8	3·8	12·2	72·4
2	24·2	62·7	3·4	13·2	14·5	—	—	75·9	5·2	24·1	78·5
3	15·8	81·1	3·0	2·1	19·3	—	—	83·2	5·4	16·8	76·0
					B—*Industrial (non-coking).*						
4	25·[illegible]	73·8	8·9	—	—	—	—	—	—	26·2	84·5
5	27·0	68·3	9·0	—	—	—	—	—	—	31·6	76·0
6	21·8	41·0	6·0	28·6	9·1	—	—	69·8	7·3	30·1	74·4
7	28·2	34·2	7·8	32·5	11·2	5·8	20·7	66·7	9·4	27·5	78·8
					SLACKS.						
8	30·0	63·6	11·4	5·3	21·7	—	—	68·9	12·2	31·1	80·0
9	30·5	71·0	9·6	—	—	—	—	—	—	29·0	86·5
					SILTS.						
10	35·5	60·2	8·1	—	—	—	—	—	—	39·8	74·0
11	33·8	48·5	11·7	—	—	—	—	—	—	51·5	78·0
12	21·5	83·8	9·9	—	—	—	—	—	—	16·2	81·5
13	45·2	59·0	12·5	—	—	—	—	—	—	40·5	82·8
					DUMPS AND WASHERY WASTE.						
14	74·0	16·8	13·0	—	—	—	—	16·8	13·0	83·2	86·6
15	40·3	53·0	7·9	—	—	—	—	53·0	7·9	47·0	75·8
16	61·2	30·2	10·1	—	—	—	—	30·2	10·1	67·8	86·1
17	76·0	14·5	13·5					—	—	83·0	87·6
18	62·2	10·8	7·2	13·5	11·6	5·0	25·8	24·3	9·6	70·7	84·8
19	62·0	13·3	6·7	9·5	12·8	6·2	34·6	22·8	9·25	71·0	82·7
20	75·0	11·5	8·2	3·2	21·0	1·5	43·0	16·2	14·0	83·8	88·5
21	63·8	24·6	8·3	4·1	26·1	—		28·7	10·8	71·3	86·5

If we were asked to state the most striking fact in the application of this process to coal-washing, we would refer without hesitation, to the facility with which it separates one grade of coal from another merely by the simple control of reagents, and without the aid of any form of screening or classification. This property renders the process so elastic in regulation that it requires only elementary skill and a little intelligence on the part of the operator in charge to produce the most profitable separation into (1) fine, high-grade, low-ash coal; (2) band, bone, or bastard coal of dull appearance, and high combined ash; and (3) shales, clays, gypsum, etc., compatible with the type of coal treated, and the purposes for which the products are intended.

The seeparation of the bone, band, or bastard coal, as shown above, is new in the annals of colliery practice, since this cannot be removed by gravity treatment, its separation in this case being entirely a matter of surface tension. The ash-content in band-coal may be said to be almost entirely molecularly mixed with the carbonaceous substances, and no degree of crushing and washing would effect its purification. The fact of its removal by froth flotation means that the true coal is thus available for the manufacture of fuels of a new standard, and indicates a probable revolution in blast-furnace practice. We have succeeded in making coke from this concentrate containing 4.8 to 5.0 per cent. of ash, whose physical strength was beyond anything in our experience.

Results.—In the course of our investigations we have made a very large number of tests, the majority of which were made with objects outside the scope of the present paper. To enumerate these results would be tedious, and we content ourselves by giving in tabular form (Table IV.) a selection which illustrates the points we have discussed.

Economic Aspects of the Process.—From a technical point of view we were convinced by our experience that the new process was a distinct success, and a careful enquiry into the economic aspect of the question assured us that flotation, applied to coal-washing, could in no way be compared to the use of a Dreadnought as a ferry-boat; quite to the contrary, examination shows that its introduction will bring a comfortable margin of profit in the one case we have investigated, namely, the production of clean coal for making blast-furnace coke.

It may be argued that the rejection of the band-coal could not be economically supported by the colliery industry, and, indeed, we cannot afford to reject anything in the trade which is combustible. We hold, however, that in the preparation of metallurgical coke this band-coal should be isolated and applied for purposes of combustion where its high ash-content cannot materially interfere with the economy of such processes. We suggest that this material should be better employed, say, for combustion purposes in raising steam and the manufacture of producer-gas, rather than be charged into the blast-furnace to make slag, with its concommitant extravagance. Accepting as an axiom that nothing should be charged into the blast-furnace but materials which would make for the most economic manufacture of pig-iron, our investigations into froth flotation have brought us to the decision that only coke made from true coal should be utilized for the manufacture of pig-iron.

Some of the most obvious advantages accruing from the flotation of coal for the production of blast-furnace coke for the smelting of iron and steel may be categorically summarized as follows:—

(1) **Ash Reduction.**—Saving in cost of handling, particularly where the place of the production of the material to be coked is situated at some distance from the coke-ovens.

(2) **Economy in Coking.**—The product is more highly bituminous, yields a richer gas and a larger quantity of bye-product, whilst the ash reduction admits of a larger efficient charge to the coke-ovens.

(3) **Production of Superior Coke.**—The coke produced is, for blast-furnace purposes, superior to any other. It is harder and denser, yet highly porous; it contains a minimum of ash, sometimes under 4 per cent.; it resists the crushing effect in the blast-furnace, and offers all those advantages which only such a coke could offer.

(4) **Economy in Furnace Space.**—There is more room for an increased quantity of iron-ores and fluxes.

(5) **Minimum of Silica owing to Ash Reduction.** — Less coke consumption required and less limestone flux per ton of ore.

(6) **Economy of Thermal Efficiency of Blast-furnace.**—The production of slag is reduced. Fewer thermal units are therefore employed in its formation, and fewer taken from the furnace by the molten slag.

(7) **Density of Coke means less Fines.**—The very dense coke means a greater quantity of large coke and the screening out of a lesser quantity of fines. The **total value** of the product of the oven is thus raised.

(8) **Maximum Thermal Efficiency at Critical Zone of Furnace.**—The resistance of the hard coke to the crushing effect of the furnace burden minimizes the tendency towards coke-consumption in the upper zones of the furnace, and the maximum number of heat-units

is developed at the tuyere lines, or, in other words, at the point of highest thermal effectiveness.

From long experience with a given plant, we are prepared to resolve the foregoing economies into a reduction in cost of manufacture, working upon ordinary Cleveland ironstone, as between gravity washing and flotation washing as follows:

For the Production of 1 Ton of Pig-iron.

	Cwts.
Burden of coke with 10 per cent. of ash from modern washery product coal	23
Burden of coke with 5.5 per cent. of ash from flotation product coal	21
Economy in coke	2

	Cwts.
Economy in limestone..	1.5

Saving per ton of Pig-iron produced.

	s.	d.
2 cwt. coke at 62s. 9d. per ton	6	3.3
1.5 cwt. limestone at 9s. 6d. per ton.. ..	1	2.4
Saving in coke and flux alone	7	5.7

This is equivalent to

	s.	d.
Saving per ton of coking coal	5	8.40
Allowing for ash discarded at 41s. per ton	1	10.73
	3	9.67
Less royalty	0	6.00
Net gain per ton of iron	3	3.67

In our calculations we assumed that the bone coal, which is of similar ash value to the raw material, will be utilized at its purchase value for processes outside the manufacture of pig-iron coke.

As the cost of flotation is practically the same as that of jig-washing, it is clear that the economies of the process are perfectly sound.

The extraordinary flexibility of the flotation method of washing coal, which permits of the treatment of all grades of fuel down to the smallest dust, will, in our opinion, become an asset of national importance. There is no pit-heap containing coal, or washery heap, or fine dust, or other colliery waste, from which the coal cannot be completely recovered by this method of treatment. It may prove that valuable business can be established in the purchase of waste-heaps, which colliery firms have hitherto neglected. The adoption of this process will render available for use in the iron and steel industries, and other consumers of coal, large quantities of fuel which have hitherto been regarded as valueless, or even, in some cases, been thrown to waste.

The flotation method does not, of course, compete with washers treating nut-coal for sale on the open market for boiler-firing, etc.; it can be employed only where the original coal is fine or where crushing is part of the normal treatment—that is, for coking, gas making, briquetting, coal-dust firing, colloidal fuel, etc.

We desire to record the very able services of Mr. F. Butler-Jones, Mr. A. Bicknell, and Mr. Arnold Bury, whose experimental work has been indefatigable in this research.

MR. GORDON PERRY, TORONTO.

Mr. Gordon Perry, president and general manager of the National Iron Corporation, Limited, Toronto, has returned to the city after a trip to England, where he saw the installation and operation of the De Lavaud Centrifigal Process of pipe manufacture in the big plant of the Stanton Iron Works Company at Nottingham, England. Before leaving Mr. Perry saw the

Mr. Gordon F. Perry, president and general manager, National Iron Corporation, Limited, Toronto.

pipe manufacturing plant started and it now has a capacity of 300,000 tons a year. The National Iron Corporation has had the De Lavaud Centrifigal Process in operation at their Toronto plant for some time and has a stock of pipe on hand now, made from the new process, which has proved very successful. Mr. Perry is a director of the International De Lavaud Manufacturing Corporation, a company that has been organized to control the patents for the De Lavaud process for casting iron pipe by centrifugal force. He is also president and chairman of the board of directors of the English Electric Company, Limited, a Canadian company incorporated with a Dominion charter to handle the business in Canada of the English Electric Company, Limited, of London, Eng. Regarding the plans for the Canadian company, which, it is stated will have a big plant in Toronto, Mr. Perry informed "Iron and Steel of Canada" that there would be nothing official to give out for several weeks yet.

Mr. Perry is an interesting and prominent figure in Canadian iron and steel circles. He was born in Dundas, Ont., and was educated in Toronto. After serving four year's apprenticeship in the foundry and machine shop of the Canada Foundry Company, Limited, now Canadian Allis-Chalmers, Limited, Toronto, Mr. Perry became a salesman for the firm in 1904 and two years later he was promoted to become general manager of the then newly incorporated National Iron Works, Limited, which subsequently became the National Iron Corporation, Limited. Working jointly with the late Cawthra Mulock, Mr. Perry successfully established the modern foundry on Cherry Street, Toronto, for the manufacture of cast iron water and gas pipe, and upon Mr. Mulock's death he succeeded to the presidency of the company. He is vice-president of the National Steamship Company; vice-president Eastern Construction Company; director O'Keefe Brewing Co.; vice-president of the newly incorporated Drifting Sand Filter Company, Limited, and a director of several other companies.

J. W. CUMMINGS CO., NEW GLASGOW.

An electric furnace has been added to the plant of the J. W. Cummings Co. at New Glasgow, and the first heat was poured on the 7th April. Messrs. J. M. Robertson, C. A. Pascoe and Sanford Davis of Montreal have installed the furnace, which has a capacity of 1½ tons. This is the first electric furnace installed east of Montreal, and will be used for making steel castings. The J. W. Cummings Co. has built up a large business in miners' tools, and is one of the several plants at New Glasgow that have grown to substantial proportions from very small beginnings.

EDITORIAL

Future of Steel Industry is Dependent on the Cost of Coal

Charles M. Schwab told the American Iron & Steel Institute at the recent meeting his belief that "in the long run, the steel trade will look back upon the present house-cleaning period as one of great advantage to the industry" inasmuch as operating economies would be forced on steel-makers.

Judge Gary stated at the same gathering "unless and until wage rates are further decreased costs of many steel producers will not permit lower selling prices". He intimated that further reductions in steel selling-prices were likely.

The publicly-expressed views of these leaders of the steel industry in the United States are in some respects delightfully vague, and remarkable chiefly for the things that have not been said, to grasp which it is necessary to read between the lines. What economies and what wages have Messrs. Schwab and Gary in mind? Not entirely, we believe, those directly connected with the processes of steel manufacture. More perhaps than is the case in any industry of comparable size, the steel industry's production costs are dependent on the costs of assembled raw materials and the transportation cost of finished materials to a market. The wages paid to the actual steel-workers are by no means the deciding factor. What then is the deciding factor? Chiefly, it is believed, the cost of bituminous coal.

The effect of the cost of coal upon the steel manufacturer is manifold. First, there is the increased cost of manufacture actually arising from the consumption of coal in steel-making processes. Second, is the increased cost of iron-ore and limestone, arising from the increased cost of rail and water transportation, both a direct result of increased cost of boiler-coal. There is also the not inconsiderable item of the increased cost of coal used for power-raising purposes at the ore mines and quarries. Third, is the increased cost of delivering steel to the consumer, caused by higher freight rates, similarly necessitated by high coal-costs.

The cost of coal, and its ramified effects upon wages, costs of raw materials, costs of assemblage, of manufacture, and of distribution; and its effect also as a deterrent to all large construction undertakings, is the major preoccupation of the steel executive. It is the root and cause of all his troubles, not only in the United States but wherever steel is being made today.

That this should be the case is in the nature of things, most manufacturing industries, and the steel industry above all, being outgrowths of the presence of large bodies of bituminous coal mineable at moderate cost. The enormous steel output of the United States is made possible by that country's large coal deposits, as has been the steel industry of Britain by that country's coal-fields, and the steel industries of Belgium, Germany, Silesia and that which once existed in Russia. Probably, however, there is no country in the world where a steel industry has been so definitely the outgrowth of the availability of coal as the United States, for the great plants of Pittsburgh are not so much a reflex of the presence of iron-ore near Lake Superior as of the occurrence of coal in Pennsylvania. When therefore, as has happened, the cost of coal has greatly increased, the main prop of the steel industry in the United States has been displaced, because it is on the availability of much good coal at the cheapest cost in all the world that the steel industry in the United States is reared.

It is not easy to state how much of the cost of finished steel represents the use of coal, because the increase in living costs, in commodity prices, and consequently in wages, is a direct and indirect result of the increased cost of producing coal. Coal, in its various uses, probably represents at least half the cost of steel manufacture, and, if distribution be added, it probably represents much more in the final cost to the consumer. Without attempting any analysis of the coal component in steel costs, it is sufficient for our purpose to state that coal is the most important factor in the cost of finished steel.

What are the prospects for lowered coal prices? They are not promising. Some reduction in miners' wages will eventually take place, and as commodity prices decline, the cost of mine material will lessen. There is also the possibility of lowering coal-production costs by better mining methods, and the cost of its transportation by more equable distribution throughout the year. These are the constructive factors in the situation. Opposing them, however, are factors tending to force up the cost of coal production. Most important is the factor of depletion, in actual reduction of reserves of coal in the ground, and in diminution of coal of good quality and such accessibility as will allow moderate extraction costs. Any possible improvement in operating methods will be unable to offset this tendency of coal-cost increase. There is also extreme likelihood that considerations of safety of human life will force United

States coal operators to abandon some of the mining methods now usual in that country, admittedly tending to [illegible] coal production, but admittedly also unsafe. Some increase in coal cost may be expected in this connection. The quality of labour available for coalmine operation is changing, and the tendency of the times is to require the work of more men, at higher individual rates of pay, to mine a given tonnage of coal. Many workmen, of the higher grades, will not today work at a coal mine, nor will they bring up their sons to do so. The price to be paid for the acquisition and the retention of coal-mine workers in the future includes a general enlargement of the standard of living among the mining population, and many considerations of hours of work and wages that do not permit of any optimism in regard to possible reduction of coal-getting costs from the point of expenditures on labour. It seems very certain that coal will not return to anything like the pre-war cost of production, which means that it cannot be sold at anything like pre-war prices.

A further consideration is that for many years the cost of coal has been an improperly low one, an incorrect one indeed, due to the fact that coal-mine operators have not included in their cost-sheets all the items they should have, and in particular the items of redemption of capital, depreciation of mining equiment, and depletion of areas. Mine costs of today, if properly calculated, should include sufficient to recoup for some of the omissions of the past, and to meet the obligations of the future. Actually, operating mine-costs today do include certain inescapable items, associated with the age of a mine, that should have been added to the cost of coal mined and consumed by a past generation. As some persistence in incorrect book-keeping may be anticipated, it is evident there will be additional jumps in the cost of coal in days to come, as it is from time to time discovered that the physical condition of the coal mines does not correspond with their reputed book-values.

Sufficient has been stated to indicate that the hope of reduction in steel-making costs arising from a reduction in coal-mining costs is a slim one, and rather temporary also. The price of coal during the past few years has shown some extensive ups and downs, but these movements have been described on a curve that is steadily ascending. Corrected to correspond with commodity indexes, and ignoring price fluctuations that have arisen from transportation breakdowns only, it will be found that the cost of coal has risen steadily for years back, and it must continue to rise steadily indefinitely and without any reversing of this tendency.

Judge Gary stated: "There is an abundance of new business, with both ability and inclination to place it, waiting for further adjustments which will put costs of living, selling prices, wage rates and general incomes on a relative parity. *As usual many will wait too long*".

Would it not be well for both producers of steel and customers to realise that stoppage of coal production will not remarkably decrease the cost of coal at the present time, but will very definitely increase it in the near future? Would it not also be well to realise that return to pre-war prices of steel, or anything like them, is an impossible hope, and would, if attempted, have a short life, followed by financial disaster of a widespread nature?

The stabilization of the steel industry must rest upon a recognition of what may be decided to be the reasonably permanent course of the cost of coal in the future. Except with regard to some isolated lines of steel goods, reduction of selling prices of steel is not within the power of the steel manufacturer, who will find it better not to operate than to attempt reductions, with the public under the delusion that coal costs are likely to tumble, as have the costs of wheat, wool, copper and some commodities susceptible of storage, without which the world can get along temporarily. It is not the steel manufacturer's move. In some respects he is but the middleman, and must wait upon the initial producer.

With regard to economies, it seems quite probable that only those steel plants that use coal as a fuel with first regard to economy and complete use of the heat it produces, can hope to compete in ordinary peace-time markets. Coal has been cheap, so cheap indeed that people got it for less than it cost the mine operators, but wastefulness and bad book-keeping will exact full revenge. Coal is going to cost more—permanently more. No substitute is known for it in steel manufacture. Fuel economy is likely to be a much debated question among iron and steel makers of the future. On the cost of coal depends the very life of the steel industry at this time.

DETERIORATED QUALITY OF WORKING ORGANIZATIONS CAUSED BY WAR.

In a paper read before the Royal Statistical Society by R. J. A. Pearson on "A Comparison of Pre-war and Post-war Production Costs in Engineering", which applies to British conditions, it is estimated that the wages of unskilled labour have risen by 235 percent, whereas those of semi-skilled and skilled labour are higher by 160 and 123 percent respectively, whilst salaries have advanced on the average by some 75 percent.

These figures, particularly those relating to unskilled labour, throw a light on the lowering of production which has been so world-wide an experience of the post-war period to date, when it is realised that the percentage of unskilled labour to semi-skilled and skilled workmen is very much greater than it was before the war. The dilution of skilled labour which was a measure of necessity during the war still persists, and the continued overloading of working organizations with

unskilled workers (or what is not quite the same thing, with workers employed on unskilled divisions of work) is being perpetuated by the high wages now paid to common labour. It has been rather unfeelingly said that "common labour" was before the war paid at low rates because it was common, but there is much hard truth in the statement. In the days before the war men were induced to look for the more "skilled" (a term that is very often synonymous with "strenuous") branches of employment because they were better paid. Today, the differential between common and skilled labour has been in very many cases so reduced that there is no pressure upon the worker to change from an unskilled, or easy, job to one that makes heavier demands upon brain and muscle.

There is also a further consideration, namely, that the skilled men in industry were—because they were the fittest types for war, by reason of mentality and physique—more heavily drawn upon by the military drafts. There has been a double disorganization of working forces, namely, withdrawal of the fittest and addition to the numbers of the less fit. Owing to the complexities of trades unionism, and fear of popular disorder, the cause of the unskilled worker has become commingled with that of the skilled worker, and probably the strongest force that is preventing a return to pre-war arrangement of working organizations at this time is the attitude of the skilled workers in opposing reduction in the numbers and in the remuneration of the unskilled workmen.

The unskilled worker was given advances in wages, while living costs were rising, greater in extent than the advances given to skilled workers, because the unskilled worker earns what is known as a marginal wage. It may be that the tendency of the times will be such as not to demand a proportionately greater rate of decrease in wages from the unskilled worker in the post-war period, but it is certain that if he is to retain any part of his increased relative remuneration it will be necessary to restore the old balance between unskilled and skilled workers in industrial organizations.

Mr. Pearson points out that it is generally recognised that cost per article increases as output diminishes, but few people appreciate how small a reduction in output will turn profits into losses. He has prepared a table showing that losses commence when a reduction of twenty percent from normal output has taken place, and that below this figure the losses rapidly increase in amount. b

Mr. Pearson concludes that a "retarded rate of production, due possibly to a combination of slackness in organization and a deliberate lowering of intensity of effort, has greatly assisted to precipitate and aggravate the present depression".

There has no doubt been much slackness in organization, but it would be preferable to term the condition one of enforced disorganization. It is also a hard thing to believe that there has been any deliberate lowering of intensity of effort by the workmen. What there has undoubtedly been is a great deal of misunderstanding of the effect of the unbalancing of the proportions of unskilled and skilled workers in industry, and some understandable hesitation to tackle a problem which can only be solved by throwing out of employment many unskilled workers or making skilled workers out of them—a procedure that is only very partially possible.

A recent report from Germany is typical of the condition above referred to. In the Ruhr field there is a shortage of "hewers" (that is coal-cutters) in the coal-mines, and it has been found necessary to institute schools of instruction, and what is translated as "instruction comradeships" to restore the proportion of skilled workers. The same procedure might be applied to a thousand industries, but the condition is most aggravated where the "skill" required consists really of a combination of manly fitness, namely suitable age, physique and enterprising mentality. The war and disease, and some war times conditions that need not be particularised, have left a residue of aged, unfit, feeble and slack elements in all belligerent populations that is greater than the pre-war proportion because of the loss of so many of the fittest in the actual fields of war. If those who have to consider these questions would recognise the wastage of war in industry, there would be less unfair criticism of the productivity of the worker and more sympathy with the industrial executive on whom rests the duty, and the onus, of correcting—as far as it may be corrected—the deterioration of the quality of working forces which is a direct result of the drain of war upon the best elements of the population.

THE RESEARCH INSTITUTE BILL.

Many sins have been committed in the name of economy, and the killing of the Research Institute Bill by the Senate is one of them. It would have been better had the senators attributed their action to any motive but that of economy, because the essence and the soul of the Research Institute proposal was that of economy. Not of course that unlovely and foolish imitation of economy known as parsimony, but true economy, the art of making much out of little, or what is ignorantly regarded as little. In all probability the coincidence of the proposal to abolish the Commission of Conservation with the proposal to institute the Research Institute was the main occasion of the action of the Senate, it being an obvious inference that the last-named body would supersede and take over the duties of the first-named. Obvious as such an assumption might seem, it would necessarily be incorrect, as the scope of the work of the Commission of Conservation did not touch, let alone conflict, with that of the proposed Research Institute, and it will later be recognised that the abolition of the Commission of Conservation is an error equal to that

made in preventing the creation of the Research Institute.

The members of the Senate who spoke against the bill for a Research Institute referred to the enormous financial deficit of Canada, and the undesirability of adding to it by the creation of another department entailing some cost. The existence of this deficit is, to a considerable extent, a result of lack of utilization of our own natural resources, and Senator McLennan well said it would be a pity if economy were exercised in a quarter and upon a project which would retard national progress.

The action of the Senate is less understandable when it is known that it has been conducting an enquiry into the natural resources of Canada, with particular regard to fuel, oil-shales and iron-ore. Certain members of the Senate are very well aware that Canada is threatened in everything that pertains to the comfort and happiness of her people, and in her very existence as a sovereign state, by the deplorably inadequate state of development of her fuel and iron-ore deposits, by waste of forests and fisheries, and lack of oil-yielding resources under commercial development. Senator Beaubien assessed the action of the Senate accurately by saying that rejection of the bill would place a grave responsibility upon the Senate. It is merely an aggravation of the Senate's action in reversing the decision of the House of Commons, and in assuming responsibility for blocking a policy that is being followed by every enlightened nation, to plead economy. It is not economy for Canada to buy goods abroad that can be mined or produced at home, and it is the finest economy to develop processes that will prevent such a necessity. Senator Dandurand feared the country was entering a field that would involve the expenditure of millions of dollars, "something it could not afford". Those who see how perilous Canada's position really is were hoping the country would have the courage and the wisdom to take precisely the action feared by Senator Dandurand, and believe the short-sighted parsimony that dictates caution in the development of scientific research is also precisely what Canada cannot afford, and the very thing that is making her poor and appallingly dependent. Those who oppose the formation of a Research Institute "purely on financial grounds" as Senator Turiff expressed himself, might find much better fields for economy.

It is only possible to assume that the necessity for a Research Institute is not comprehended by the Senate, as a whole. Possibly the Senate, and other bodies representing the Canadian people, would take a different view of their responsibilities if they realised that unless Canada does very quickly begin to use what raw materials she possesses, the Senate and all other bodies of popular government will disappear because we shall be absorbed by nations who do believe in helping themselves.

WORKMEN'S COMPENSATION.

Without desiring to criticise the wisdom of workmen's compensation enactments, which stand on our statute books as a reflex of public opinion, and represent one of the advances in social responsibility that mark our times, it is permissible to point out the cumulative nature of the expenditures required. In Nova Scotia, as in Ontario, the history of workmen's compensation has been that of progressive enlargement of the application of the principle that the worker is entitled to be compensated for injuries sustained in the course of his employment out of the revenue raised by the product of that employment. In Nova Scotia the enlargement noted has led to inclusion of occupations that were at first excluded, to larger rates of compensation, to the inclusion of medical aid and nursing, and to increasing cost of administration. It is not probable that this tendency to enlargement will be lessened, and it certainly will not be reversed.

The most satisfactory feature in what the Nova Scotia Compensation Report for 1920 calls a "monopolistic state-board system" is the elimination of all legal expenses and the fact that all monies collected by assessments on the payrolls is paid without diminution — except for administration expenses — to the parties intended to benefit. It is the unnecessary expenditure on litigation arising out of compensation claims that is so distasteful and so harmful a feature of the compensation laws of the province of Quebec, and is responsible for the pressure that is being brought upon the legislature of that province to adopt the system of administration by a provincial board that is now customary in virtually every other province in Canada.

There are so many points on which it is possible for employers to disagree with their workmen, and vice-versa, that operating executives would secretly, if not openly, welcome a system that avoids the necessity for all dispute and all legal recourse in compensation claims. The Board in Nova Scotia is able to claim that it has disbursed compensation assessments raised on an annual payroll of $73,000,000, extending over four years, without expending a cent in solicitors' fees. This is not a remarkable achievement in administration, because it is inherent in the nature of the system, but it is an achievement that stands out in these days of disputation. Once the principle of workmen's compensation is admitted, it is a right and logical procedure to adopt the best method of carrying out that principle, and that is why the appointment of a competent board as paymaster and sole referee has supplanted all other methods, or is about to.

GEOLOGICAL SURVEY SENDS PARTY TO BELCHER ISLANDS.

Dr. G. A. Young, with a party of ten, is being sent to the Belcher Islands to make detailed examinations of the iron-ore occurrences there. Outfitting supplies were obtained in Cochrane towards the end of May, and the party will make a start as early as possible, proceeding from Pagwa to Hudson Bay by motor-boat.

RAILWAY EQUIPMENT ORDERS HELPING.

Equipment orders for the railways have assisted the steel plants in Canada. The Algoma Steel Corporation is working on a government rail order and its plant is almost fully employed. The Steel Company of Canada at Hamilton has announced its intention to work four days a week, which will be a considerable improvement on the rate of operation that has for some time been possible. The Sydney Plant is commencing work on a government rail order, and the Scotia plant at New Glasgow will be given employment through an order for rail fastenings and accessories. On the eve of resumption of steel-making at Sydney a number of employees on the narrow-gauge tracks in the Plant, who have been given employment during a period when their services could have been dispensed with, have ceased work ostensibly in support of railway employees of the Dominion and Scotia companies who struck for higher wages last Autumn. As an indication of lack of understanding of the depressed state of the steel industry in North America, and as an instance of folly, this action of the Sydney railwaymen would be difficult to excel.

SLAG-CRUSHING PLANT FOR MAKING ROAD METAL AT SYDNEY.

At the Dominion Steel Plant in Sydney a slag-crushing plant for the preparation of road-metal has recently been completed, and is now in operation. Weathered slag is taken from the slag-dump, from whence it is dug and loaded by steam shovel. The loaded cars are emptied into a large receiving bin, the slag first being passed over a grizzly, which rejects unsuitable material, and large pieces holding iron. The slag is crushed by a large Gates crusher, and after crushing is elevated sixty feet to a screening-floor. The crushed material is passed over a weakly magnetic belt, which removes iron particles, and pieces of iron-containing slag. Passing through a revolving cylinder-screen the crushed slag is separated into four sizes, namely:

below ¼ inch
from ¼ inch to ¾ inch
" ¾ inch to 1½ inches
" 1½ inches to 3 inches.

The relative quantity of the various sizes can be modified between the above-mentioned limits by regulating the crusher. The cylinder-screen deposits the crushed slag into four bins, each of about 100 tons capacity. The bins are equipped with gates for loading direct into railway cars, and with shoots for loading motor-trucks. Large shipments of slag have already been made to local county and municipal authorities for use on the highways, and quick advantage has been taken of this easily accessible source of a road-building and mending material that is ready for use, and is available in the grader sizes required for the various stages of road work, from first building to occasional repairs.

The Dominion Iron & Steel Co. has used crushed slag for the past two years for road-building, railway ballasting, and for an aggregate in concrete in heavy construction work. It was largely because of the uniformly satisfactory experience of the Company's engineers with crushed slag that the new plant was built, and the local demand has so far been fully up to expectations.

Tests in the Dominion Steel Company's laboratory have demonstrated that slag is the lightest aggregate-material that is available, and its strengh is not surpassed by the best stone aggregate. Its chemical composition is such that it cannot disintegrate. Its porous structure and decided angularity give it superior bonding qualities. Being a product of the blast-furnace it is resistant to fire and will not crack or spall under intense heat. It will not absorb or transmit moisture, and therefore constitutes an effective barrier to moisture.

As a material for making macadam roads, crushed slag is ideal, and it is so used in European countries where slag is available to the exclusion of all other road-making materials, either with or without the addition of tar and sand in tar macadam or ashphalt roads. Crushed slag for road-metal is a general by-product of all European steel plants.

As a railway ballasting material it has proved ideal, and it has excellent bonding qualities, combined with good drainage. It kills weeds, and has proved to double the life of railway ties compared to earth or rubble ballast.

The various companies now included in the British Empire Steel Corporation have for some time used crushed-slag exclusively in construction work of varied kinds.

The plant is housed in a wooden building, well equipped with fire-prevention apparatus. The Gates crusher is driven by an 85 horsepower d.c. motor, and a 35-horsepower motor operates the elevator, magnetic separator and screens. The completed plant cost about $60,000.

A very worth-while recovery of iron from the worked-over slag is expected, and has so far been realized. In addition to the iron-holding material separated by the magnetic belt, a large amount of iron is picked out in the process of digging by the steam-shovel,and such material as ladle "skulls" and lumps of iron rapidly collects between the steam-shovel and the receiving hopper of the crushing-plant.

While the amount of slag actually removed from the plant is not large, it is worth noting that the Steel Company is now experiencing difficulty in disposing of its slag and has to transport some of it several miles away from the plant for disposal. The turning of even a comparatively small quantity of slag into a profitable commercial product is therefore a double advantage. The plant is expected to dispose of 50,000 tons of crushed product annually.

"The Chateaugay Ore and Iron Company have engaged Freyn, Brassert & Company, Engineers, Chicago, for the work of remodeling their blast furnace plant at Standish, N.Y., and for the construction of a sintering plant at their mines at Lyon Mountain, N.Y. The blast furnace stack is to be enlarged in capacity and the plant modernized by the addition of mechanical handling equipment. The sintering plant at Lyon Mountain mines will supplement the ore-concentrating plant and will produce a low phosphorous copper-free sinter for shipment to the blast furnace at Standish."

Port Arthur Shipbuilding Co., Ltd., Port Arthur Ont.

By J. H. McBRADY, of Port Arthur Shipbuilding Company, Limited.

The Port Arthur Shipbuilding Company, like most other shipbuilding enterprises in America, is without orders for new construction of vessels, and has found itself with a plant, expanded in capacity during the war period, that is larger than the normal construction of vessels and ordinary ship-repairs in peace time requires. Some new line of enterprise was necessary, to bridge over the temporary dullness in ship construction, and to give an outlet to the Company's manufacturing ability. The manufacture of paper machinery has therefore been undertaken, the position of Port Arthur with regard to the pulp-timber areas of the North Country suggesting it as a logical centre. Mr. John W. Brassington has been engaged as Chief Engineer in charge of pulp and paper machinery manufacture, and is well qualified, having been for a long time in charge of design with the Pusey Jones Co., and also Chief Engineer and Operating Manager for the American Writing Paper Co., of Holyoke, Mass.

The enterprise of the Port Arthur Shipbuilding Company is commendable, showing an adaptability to changed conditions that is a necessity of commercial existence in these days of approach to the uncharted shores of "normalcy", and also a due regard to the welfare of the Company's working organization; an asset, that in an isolated centre of population like Port Arthur is of greater value than the works themselves.

Bird's Eye View of the Plant of the Port Arthur Shipbuilding Company.

One result of the Great War, whether we regret it or not, was the entrance of the Dominion of Canada into the family of nations as a full-grown entity. After the tremendous effort put forth by Canada she felt her strength, her ability to stand by herself, and in tenfold-form, her duty to her own future.

Now with uplifted countenance she looks courageously to the future and knows that in her own hands lies the making of it. She turns to her citizens and asks their support to enable her to take up the manifold duties which are a part of an independent nation.

Among these duties is the essential one of seeing that her industries are well supported, that she is self-sustaining and that the products of her industry are carried from her own shores to the ports of the world. At no time in her history has the necessity for a mercantile marine been so evident to far-seeing men.

The history of all great nations (if it tells us anything at all) writes this plainly before us—that no nation can exist in the economic struggle of the future unless she can provide ways and means for transporting her own goods to the markets of the world. The necessity for an adequate Canadian mercantile marine, so that Canadian manufacturers can ship without paying toll to other peoples, is one need of the present hour.

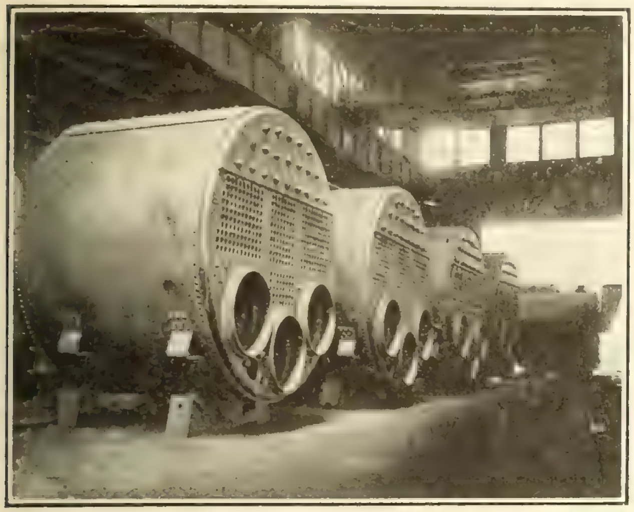
The opening of the St. Lawrence river, the development of Canada's waterways and the creation of her sea-ports in connection with the building of an adequate mercantile marine are problems which ask the attention of our statesmen today.

Laggard action on the part of Canada's statesmen now means a far-off interest of tears in the future, and unless we can find men who are capable of grasping today's opportunity, then indeed the future of Canada may be black.

This article describes the operations of the Port Arthur Shipbuilding Company, Limited, Port Arthur, Ontario, which owns a shipyard of great possibilities that can be still further enlarged, can be put in direct touch with the salt water, and is in the most advantageous position to procure the steel and provide all the raw material that goes into the building of ocean vessels.

At this time when Port Arthur is beginning to make a definite advance in the steel industry and is developing mines in the neighboring district, it does seem that here is one of the signs of the inherent possibilities of the Dominion which merits the attention of the men who are to control the present and, therefore, to a large extent, the future of Canada.

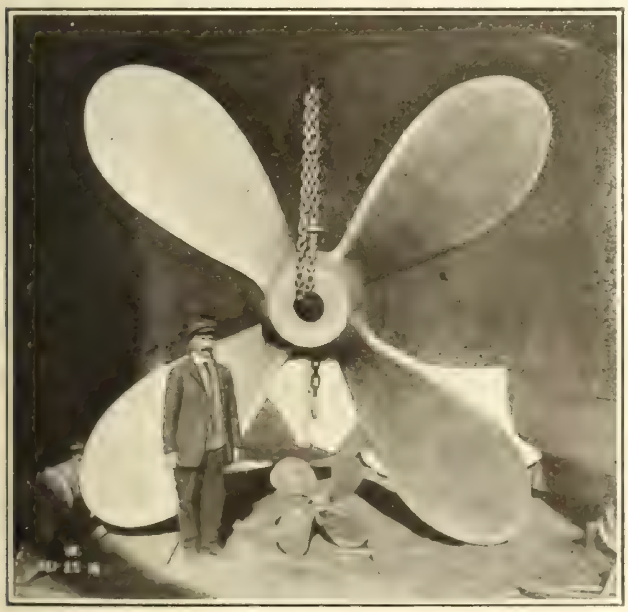
In laying before the readers of "Iron and Steel of Canada" a description of the plant of the Port Arthur Shipbuilding Company, its capacity and adaptibility, it is interesting to point out the necessary close relation between the makers of iron and steel products and those users of rolled-plates and shapes—namely, shipbuilders. It is to be hoped that harmonious relations of mutual advantage will always exist between these two great Canadian industries so as to insure the safeguarding of their future prosperity.



Battery of Scotch Machine Boilers Built at Port Arthur.

Pulp and Paper-Machinery Department.

The rapid expansion of the Pulp and Paper industry in Canada has found in Port Arthur a responsive centre. Situated as it is in the centre of Canada, it offers an ideal location for the manufacture of the machinery required in this business. Within a radius of 150 miles is one of the largest pulp-producing areas in the whole of Canada. In this territory are situated three established large pulp and paper mills, one of which ranks with the largest and most modern on the American continent. In 1920 five new mills were being built or placed under construction and three of these are within the limits of the Lake Head cities.

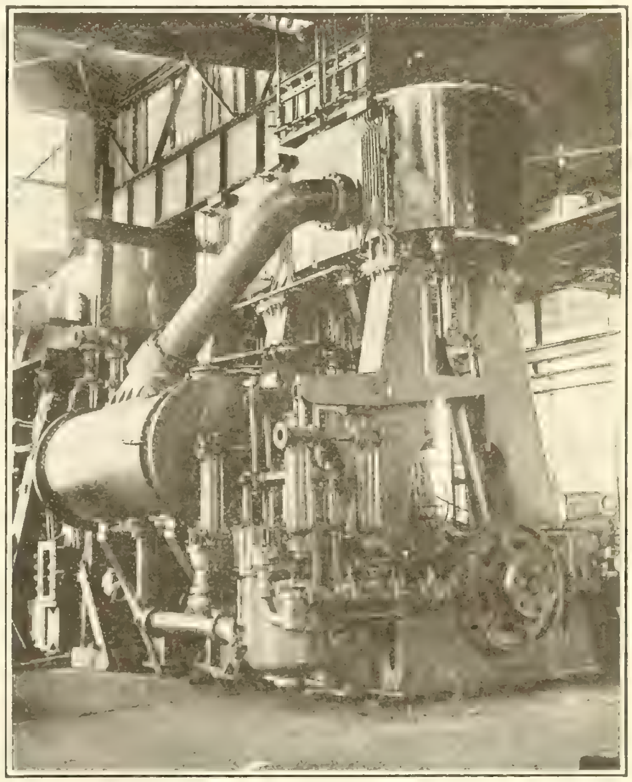


Propeller 14 ft. 6 in. dia. Cast in the Iron Foundry, Port Arthur Shipbuilding Company.

Some may ask why this shipbuilding company, with its well deserved reputation as the builder of no less than forty-six sea-going vessels, many of which are today on the high seas, and the others on the Great Lakes, amongst them being the largest vessel of all on the great inland seas, the S.S. "W. Grant Morden", should embark in the manufacture of paper machinery?

The answer is easily given. This shipyard during the world war expanded to dimensions that exceed in capacity any probable demands during times of peace for freighters to carry our products to the ports of the world.

Why paper machinery? Because, with the possible exception of the steel industry, the pulp and paper trade is today the most prominent of all manufacturing enterprises and Canada will some day be the greatest producer of pulp and paper in the world. Port Arthur, with its tremendous surrounding pulp-producing area must be the natural spearhead of this industry in Canada, and in or near Port Arthur should, as a consequence, be located a reliable source of supply of the tools of the paper trade.



Triple-Expansion Surface-Condensing Engine, 1900 h.p., 82 r.p.m. Built by Port Arthur Shipbuilding Co.

In addition to the commercial reasons that caused this company to enter into this new line of manufacture, is its feeling of responsibility towards the hundreds of their employees living in the immediate neighborhood, and their desire to secure to them a means of livelihood near their own homes.

The Port Arthur Shipbuilding Company has employed in its shops 1,400 hands, having a monthly payroll from $190,000 to $200,000. The percentage of first-class mechanics among the workmen compares favorably with similar groups in any machine-building plant in the world. The machines, and the men behind them, required to build marine reciprocating-engines are as capable of manufacturing paper machinery as they have in the past proved themselves capable of producing these fine power-units, which are a worthy sample of their

achievements. And it is surely worth while to keep intact such a splendid organization with its component units of worthwhile individuals, and to take every precaution that it should not disintegrate now when the demand for ships is reduced.

This company believes that it could choose no better way of ensuring not only its own future, but the future of its employees than by entering into the manufacture of paper machines, so necessary to the Canadian pulp and paper industry, which may become not only the most important commercial enterprise in Canada, but, very possibly, the greatest industry of its kind in the world.

In considering the advisability of building pulp and paper machinery the Port Arthur Company, developed the fact that paper-machine building is not as high a grade of the art of machine-building as machine-tool work or reciprocating-engine work, but really grades somewhere between these two types and the rougher classes typified by agricultural machinery. The Company concluded that there is no reason why any well-appointed machine shop provided with the proper plans and specifications should not build as successful a paper machine as the oldest and best of those manufacturers who have been engaged in paper-machine building for generations.

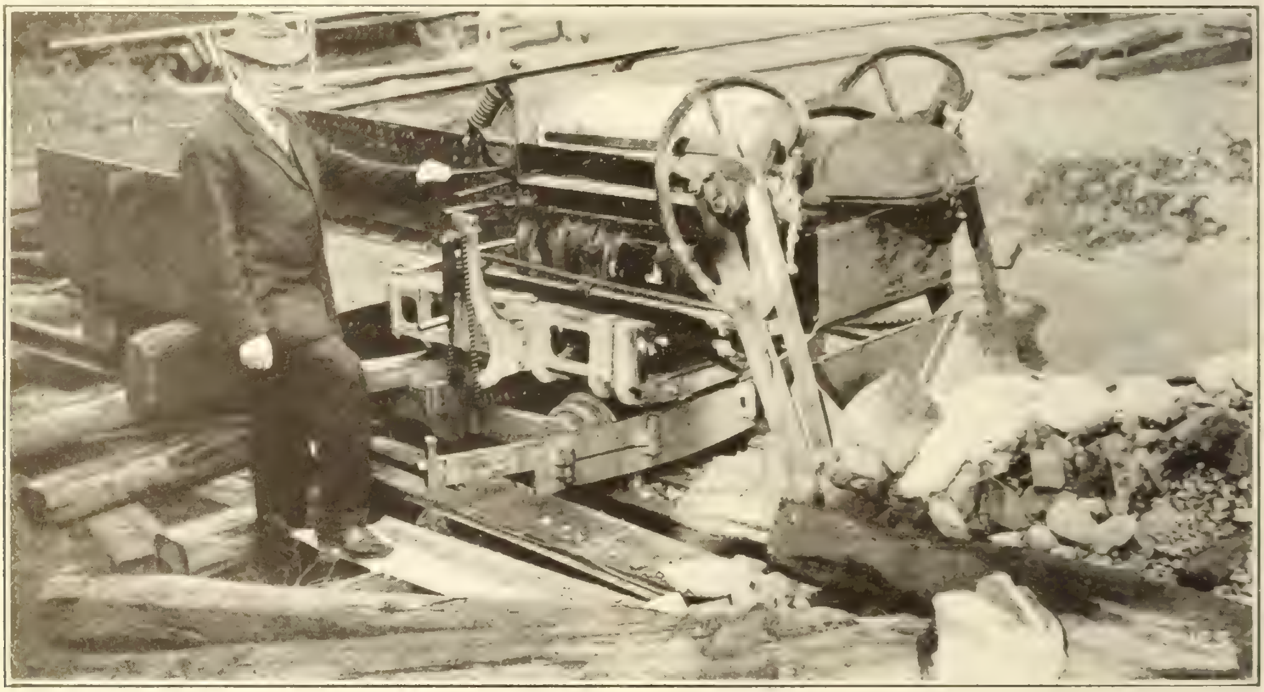
This conclusion has been confirmed by the success achieved by the Dominion Engineering Works in building the great "News" machines for the Laurentide Company. These machines are not only the first that the Dominion Engineering Works built, but in their manufacture they had the assistance of only one man familiar with the art of Paper machine building.

In this particular case old-established precedents and methods of paper-machine building were departed from, with the result that this machine probably represents the most advanced type of paper machine ever built, being capable of a paper speed of at least 1,000 feet per minute and lending itself in its basic design to easy operation and facile change of clothing.

The necessity for a source of supply in Canada of papermakers' tools and the fact that Canadian pulp and paper-mill owners prefer to buy in Canada, governed the wise decision to establish this new department at Port Arthur plant where it would form a necessary link in a complete and self-contained industry that has not yet, by any means, attained its full development in Canada. There is a national purpose in establishing a world-leading trade at home which should appeal to every Canadian buyer.

The Port Arthur Shipbuilding Company therefore asks for an opportunity to supply Canadian mill-owners with equipment that is of the highest grade in quality and workmanship, giving thereby to the Canadian buyer an opportunity to follow the advice of Sir Henry Drayton to "buy in Canada". The present method of buying abroad is not the best method, and it is absolutely imperative for Canada's successful financial future to follow the Finance Minister's advice

Let Canadian mill-owners realize they have a duty to their country, as well as to their pockets, and waken up to the fact that the latest and most efficient products in pulp and paper-machinery design are being made in Canada, can be bought in Canada at as fair, or fairer, prices than from foreign sources, and help to make this great Canadian natural resource and industry the future integrated success it should be "Look not to immediate profit at sacrifice of future gain. For the sake of your own future well-being, give Canadian firms the preference over those of outsiders."



"Shuveloder", Built by Port Arthur Shilpbuilding Company.

Shuveloder Construction.

The Port Arthur Shipbuilding Company has succeeded in securing the right to build for Canada the Superior "Shuveloders" and the "Hoare" Shovel, both of which are compressed-air-operated mine shovels.

The Company has just successfully filled a contract for twenty of these "Shuveloders", some of which have been shipped as far as Japan and other places in the Orient.

Men in charge of mining operations, who have seen the efficiency of these Shovels at work, speak of them as follows:

"Owing to their construction, they can be handled

in small openings with a decided advantage. It requires little time for operators to become familiar with the use of these machines and become expert in handling them. Two men can readily load 60 tons in an 8-hour shift."

"Where you are in a hurry to press a drift through, you will find it a great aid, as it will clean up a drift very quickly after a blast."

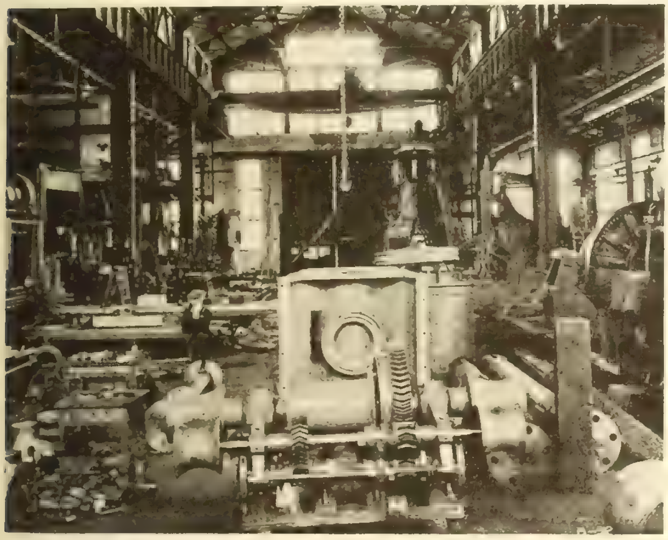
"The saving over hand labor could easily be figured at 50 per cent. The thing loads ore so fast that the trouble with it is to get enough for it to do to keep it employed."

A detailed description of the Hoar Shovel was contained in the April issue of "Iron and Steel", see page 78.

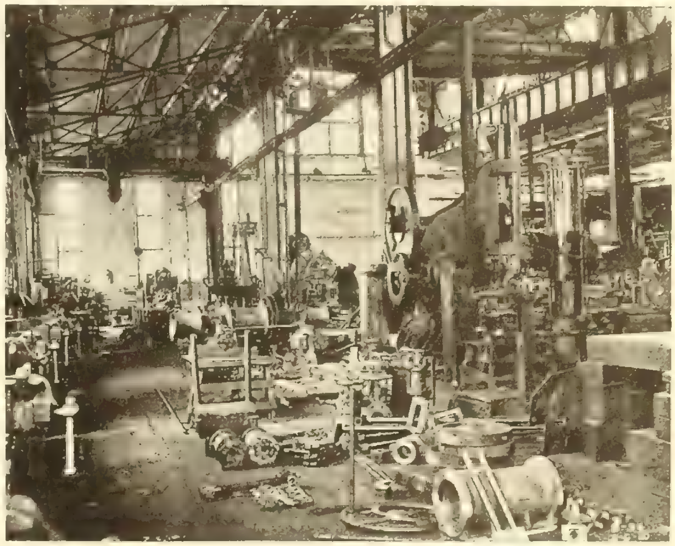
The plant is most conveniently situated for repair work, as vessels coming up the lakes with coal or ore undergo repairs at Port Arthur before loading grain for the downward trip. Vessels also winter at the Head of the Lakes, as by doing so, they can take on a cargo of grain for winter storage. These vessels make their winter repairs, renewals and alterations here and the Company is assured of a steady amount of ship-repair work.

Description of Plant.

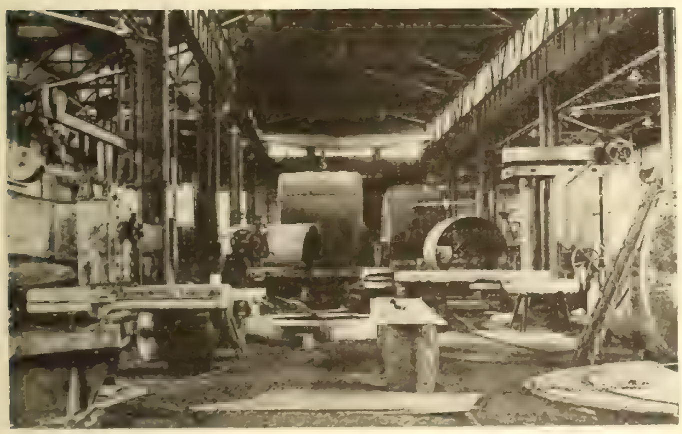
The Plant of the Port Arthur Shipbuilding Company is situated on a tract of 110 acres of ground inside the breakwater at Port Arthur, it has a water frontage of 3,030 feet with 1,250 feet of docks. The whole area is



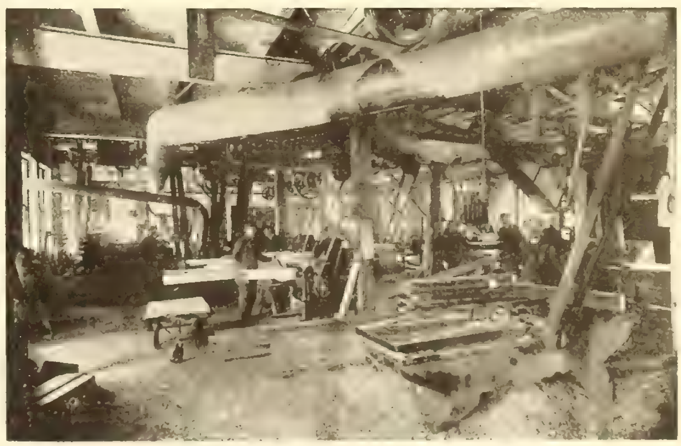
Machine Shop, Looking South.



North West Corner of Machine Shop.



Boiler Shop, Looking North.



First Floor, Joiner Shop.

Dry-Dock and Ship-Repair Department.

The Port Arthur Shipbuilding Company has the only drydock at the head of Canadian navigation and is the only firm equipped to render this service to vessels coming into Port Arthur and Fort William, which cities are the freshwater terminals of the three Canadian transcontinental railways and their ports for the transshipment of grain crops of Western Canada.

The Dry Dock is of solid concrete, length 700 feet, width at coping 98 feet 6 inches, depth at entrance 15 feet 6 inches, and is larger than is required to accommodate any vessel yet sailing the Great Lakes. It is equipped with electric pumps capable of emptying the entire dock in three hours.

served throughout by traveling cranes and standard-guage railways.

Four Building Berths:—Two on each side of drydock, served by gantry-crane and three-line aerial cableway.

Shearlegs:—Of 90-ton capacity for purpose of installing boilers, machinery, etc.

Plate and Angle Furnaces:—Respectively, 25 feet by 9 feet, and 60 feet by 4 feet. These furnaces were installed in 1918, are heated by oil and are the latest improved and most modern type.

The plant comprises 27 buildings, the ground-floor area of which equals almost 3 acres; the principal shops being:

Machine Shop:—Capable of turning out not only marine engines up to 2,000 horsepower, but the winches, windlasses and steering-engines required on a modern freighter.

Foundry:—Capable of casting cylinders and propellers for vessels and the largest cylindrical-dryers used in paper machine manufacture.

Boiler and Sheet Metal Shop:—Fully equipped with overhead cranes, hydraulic riveters, etc., and in it have been built many large Scotch boilers. This shop can easily handle the largest digesters required in a pulp mill, or build with accuracy the tanks, incinerators, evaporators, etc., required by the pulp and paper trade.

Pipe Shop:—Has furnished all the piping for large modern freighters, including the intricate copper work required. Capable of finishing the brass and copper work required on paper machines.

Blacksmith Shop:—Equipped with power-hammers, capable of supplying forgings for ship construction and the necessary forgings for paper machines.

There are, in addition, the pattern shop, carpenter and joiner shop, erecting shed, electric shop, air-tool shop, and other miscellaneous buildings.

The Plant is operated with the aid of electrical, compressed-air, and hydraulic power. Steam is used for heating purposes only.

General View.—Port Arthur Shipbuilding Company's Plant.

The Welding of Steel in Relation to the Occurrence of pipe, Blowholes and Segregates in Ingots

By COLONEL DAVID CARNEGIE, M.I.C.E., F.R.S. Edin.

At the annual meeting of the Iron and Steel Institute held in London on May 5th and 6th, one of the papers, which is full of interest to all manufacturers of steel had the above title for its subject. Mr. Harry Brearly, a member of the Council of the Institute, and an authority on the diseases of ingot steel, dealt with the subjects most ably. At the conclusion of the long discussion the president, Dr. Stead, F.R.S., very appropriately measured the opinion of the members when he said that it was clear that more investigation was required on the subject.

The importance of the subject is alike great to makers and users of steel. Steel manufacturers know that absolutely sound ingots are impossible to obtain. Users of steel are not as a rule concerned with it at the ingot stage, but in the product from the ingot. It is, however, a common practice for engineers to specify certain tests both chemical and physical as a basis of acceptance of the products from the ingots.

Munitions Steel.

In the supply of steel for munitions, Canadian manufacturers had difficulty, during the war, in producing ingots for shells which, when fractured longitudinally, were entirely free from some form of "piping" "segregation" or "contraction cavities," even when the stipulated "head" was removed. These defects though in many cases very slight gave rise to the fear of unsoundness in the base of the shell when forged direct from the cast ingot. Many experiments were carried out with a view to proving that contraction cavities, tears, and looseness in the fracture of cast ingots were all satisfactorily welded during the process of punching the cavity in the steel ingot. It was proved that when transverse tensile tests taken from the base of shells forged from ingots, which were known to have the above defects, that the physical results obtained were equal to those from test pieces taken from the walls of the same shells where no such defects existed. From the results of many experiments we were encouraged to believe that such ingot defects were welded.

Steel Welded under Pressure.

Mr. Brearly says and other authorities confirm the fact that "hot steel can be welded together under pressure at low temperatures in an atmosphere of hydrogen or other inert gas," but his experiments go to prove the unreliability of steels used in ordinary practice welding together perfectly owing to the ease with which steel oxidizes and the difficulty in removing the film of scale, however fine, which prevents the metals separated by the scale from uniting. With regard to the welding of blowholes in ingots Dr. Stead and others have concluded from microscopic evidence "that welding of blowhole cavities as a rule is complete and perfect," their conclusions have been based upon experimental evidence and support the conclusions formed by myself and others in Canada that it is possible to weld contraction cavities in ingots where detrimental slags and oxides do not exist. The experiments carried out during the war to which I refer were upon cast-steel shell-ingots made for one shell only. Much loss to manufacturers was caused by the rejection of shell ingots which had slight contraction cavities. Our knowledge then was not sufficiently fortified by experience to warrant the acceptance of such ingots lest unsoundness in any part of the finished shell should

result. With the object of seeking to establish grounds for the removal of such fears experiments were made with many shell ingots, one of which was to drill a ½-inch diameter hole along the central axis of different ingots to different depths and plug the holes with similar materials. The ingots were then forged in the usual way, after being heated, by punching a cavity in the material. On examination of sections of the punched ingots no traces of the bars were found, which showed that in the process of heating and forging under pressure a union of the inner bar and ingot took place.

Imperfect Welding in the Process of Rolling.

Mr. Brearly's experiments with ordinary mild steels containing 0·15 p.c. carbon and 0·35 p.c. carbon and with a 3 p.c. nickel steel, a 5 p.c. nickel casehardening steel, and a nickel-chromium steel such as is used for aero-engine shafts, were on the same lines as our Canadian experiments but the plugged billets were rolled instead of punched. Curious results were obtained from blooms of steel made of the above classes of materials when drilled along the longitudinal axis and plugged with a machined bar hermetically sealed at the ends.

When the rolled bars were nicked and broken across the welded surfaces all the steels, judging from the fractures, appeared to have welded perfectly except the 0·15 carbon steel and the 5 p.c. nickel casehardening steel. One curious thing about these tests was that the etched transverse sections of the bars showed no visible weld-lines excepting slight indications only after "much patient searching," and yet on hardening and reheating the entire series of steels so as to put all of them in a tough condition not one of them withstood the nicked-bar test, all pulling apart at the welded surfaces. These results, says the author of the paper, "explain clearly why transverse fractures of nickel steels appear to be more reedy than similar fractures made in ordinary carbon steel, i.e. the nickel steel is tougher and therefore pulls open on the faces of welded blow-holes, or slag streaks, more than in the less tough carbon-steels; the steel itself is not more reedy in the sense that it contains more slag streaks or less perfectly-welded blow-holes."

Welding of Chromium and Nickel Steel.

"It is obviously incorrect says Mr. Brearly to say that steel containing chromium cannot be welded under such conditions as apply to the welding of cavities in ingots." This is a very important point and one which was raised in the discussion by Dr. Stead in the form of the question, "Does chromium and nickel reduce the welding property of steel?"

Reason Advanced for Imperfect Welding in Rolled Blooms.

In regard to the cause of imperfect welding of the machined bars which were fitted to blooms in the experiments, one of the speakers suggested that in the rolling of the blooms there was reason to suppose that the metal of the bloom slipped or flowed along the inner bar and thus would prevent a proper weld. The slip he considered was caused because of the difference in the temperature of the outer surface of the bloom and its inside during the time of rolling.

Mr. Brearly has added very much to our knowledge of cored-blooms rolled into different shapes.

How to Detect the Pressure of Welding.

The author conducted a series of experiments with 3½-inch billets which were drilled down the axis of the billets and plugged with a machined bar of the same material 1-inch in diameter. The cored billets were rolled into bars 4½-inch x ½-inch.

A series of specimens were cut from the side and centre of each bar.

These were broken on a standard Izod machine and the impact value of the Edge specimen, whose corresponding piece cut from the centre is split along the weld, is taken as the welding figure. Four different steels were used in the experiments:

	Carbon.	Silicon.	Manganese.	Sulphur.	Phosphorous.
A	0·34	0·22	0·75	0·052	0·057
				Nickel.	Chromium.
B.	0·34	0·23	0·71	3·26	0·28
C.	0·32	0·23	0·53	3·11	0·06
D.	0·35	0·23	0·72	3·57	0·05

The test pieces were oil hardened at 850 deg. C. and tempered in stages of 100 deg. C. up to 650 deg. C. From the results of tests the comparative welding figure selected is given as follows:

Steel "A" = 28 or rather less.
" "B" = 20.
" "C" = 18.
" "D" = 14 or rather less.

"That is to say, these figures represent in Izod foot-pounds the degree of the toughness which must be induced in the steels by hardening and tempering in order to pull the welding surfaces apart in a visible gap."

Mr. Brearly showed further that if instead of rolling into flat bars, the coned billets are rolled into round, or gothic or square bars, and tensile pieces are prepared from them, the bars which have been heat-treated, to develop maximum toughness in them, will sometimes reveal the cone in the broken tensile-test piece and other times it will not be visible.

Microscopic Revelations.

From microscopic examination of transverse sections of the rolled bars, specially heat-treated to increase the separation of the ferrite in the carbon steel and promote its separation if possible, in the alloyed steel, etched sections showed a band of ferrite about the welded surface of all steels except the nickel-chromium steels.

Mr. Brearly concludes his most valuable paper with arguments and illustrations for the production of good-quality steel and Dr. Saniter very rightly remarked in the discussion that the paper dealt with sound steel and how to make it more than welded steel. I am sure the investigation of this most important subject is worthy of pursuit and I am glad to know that Mr. Morrow, of the Steel Co. of Canada as well as Mr. Spencer, of Montreal, and others in Canada have given considerable attention to this subject.

Eastern Equipment Co., Ltd., have moved from the McGill Building and taken the entire floor of 231 Beaver Hall Hill, Montreal, where they will have, in addition to their offices, an extensive show room. This firm have recently been appointed Canadian agents for St. Clair Brothers, Galt, Ont., manufacturers of pumps, concrete mixers, hoists, etc. They also handle new and rebuilt contractors' equipment of all kinds as well as locomotives.

Ironstone Mining in North Lincolnshire, England

By ROLAND H. BRIGGS, Coulsdon, Surrey.

The ironstone mining of North Lincolnshire is of increasing importance. Sixty years ago the output was only 16,000 tons per annum, by 1870 it had risen to 217,000 tons, by 1910 to 1,800,000 tons, and by 1920 to 2,400,000 tons. The iron content is low, but the ease with which the most modern mechanical methods can be applied to getting it, makes it worthy of the most thorough exploitation, and in addition its chemical constituents make it peculiarly valuable. Frodingham ironstone nearly always contains sufficient lime to enable it to be fluxed without the addition of limestone, and as it also contains about 1 per cent. of manganese, the addition of manganese ore in smelting is also unnecessary.

The first ore was quarried in 1859, and five years later the first of the local furnaces were erected for the smelting of the ore. The replacement system of mining which is carried out calls for careful organisation and operation, and in the early days much of the bottom stone was left where it was, but with modern scientific methods the whole of the bed is everywhere mined and all faces worked to their full depth.

The ironstones of Britain are found in the Jurassic rocks which stretch in a broad band across country from the coast of Yorkshire to the coast of Dorset. The ironstones occur in four different geological horizons. Some ironstone is also found in the Kent coalfield. In 1917 eighty per cent of the total native output of iron ore was found in the Jurassic rocks, the remaining 20 per cent being hematite from Cumberland and Lancashire and elsewhere, and blackband ironstone from the coal-fields.

In pre-war days cheap water-transport made it possible to import high-grade foreign ore, which contained fifty per cent of iron, but during the war it was necessary to fall back very largely on the native ironstone. These ores average about 28 per cent in iron content, and have a high phosphorous and sulphur percentage, and are generally rather siliceous. As the metallurgical treatment of these ores is different, basic-lined steel furnaces had to be substituted as rapidly as possible for the acid type. The magnesite bricks were made from material obtained from Greece and Madras, and new quarries were opened to furnish the dolomite and limestone required. The total production of iron ore in Britain is about fifteen to sixteen million tons per annum.

Mechanical methods of ore-getting in north Lincolnshire were not very quickly introduced, owing to the ease with which the ore could be obtained near the outcrop, but as the workings developed, grab-cranes were brought into action, and these proved a great improvement on hand methods. By 1905, however, the shipping had become deeper, and chain bucket-excavators were then introduced, and proved a great advance on the grab cranes, but later on these were also superseded by costly but most efficient equipment, which has reduced working costs in a remarkable degree.

The long-jib crane type of steam shovel has also become popular in the district, different types being at work which dump at a distance of 60 feet and 75 feet

Stripping the Frodingham Iron-Ore Bed.

Stripping Operations—Frodingham Iron-Ore Bed.

respectively, and when a greater distance is required, as for instance when the stripping has reached thirty feet deep, a transporter can be used in conjunction with the 60 foot machine, giving a total dumping distance for the excavated material of 120 feet or even more.

Two types of machines are being used to deal with the Frodingham bed, and the first of these has amply demonstrated its ability to deal with faces up to 16 feet in depth. The second and much larger machine was specially designed to deal with the full thickness of the Frodingham bed, which it does very effectively. Experiments are being made to show whether the smaller machine will work the full depth of stone, by fitting it with a longer jib, and as the smaller machines are much less expensive in first cost, they will probably be the type regularly installed if they will successfully handle the greater thickness.

The actual average filling-rates of these machines, taken over a period of several months, are 130 tons per hour for the smaller machine, and 186 tons per hour for the larger machine, but it should be understood that the daily total does not work out on the averages, as

Loading from the Frodingham Iron-Ore Bed.

considerable time is lost by stoppages caused by changing cars, coaling, lubricating and minor breakdowns.

The successful use of these mechanical appliances does not depend alone on the efficiency of the machinery or on the care with which it is operated. It also depends very greatly on the skill with which the blasting of the ironstone has been carried out. It was at first considered doubtful whether it was possible for the ironstone to be reduced to such limits as would be satisfactory for the blast furnace, but it has since been shown that if the drilling is carried out judiciously and the explosive used in considerable quantities, the results obtained are to the entire satisfaction of all concerned.

The drilling in most of the faces is carried out by hand machines driven by compressed air. The hole is staged down so as to finish at a diameter of 1 7/8 inch., and these are drilled every 8 or 9 feet, so that sufficient explosive can be used to shatter and distintegrate the ironstone satisfactorily.

In one of the deep faces a machine is used by means of which a hole 6 in. in diameter can be drilled. These holes are spaced at much greater intervals and carry a very powerful charge. The cost of drilling and explosive with this type of machine slightly exceeds the cost of the method in which the smaller holes at shorter intervals are used.

It will be understood that the mechanical equipment of the ironstone mines of North Lincolnshire does not end with the excavating plant for the actual getting of the ore. The mines are complete with up-to-date power-houses, railways, locomotives and rolling stock, air compressors, and other machinery, which enable this area to make so considerable a contribution to the iron-ore supplies of Britain.

In conclusion the writer wishes to express his thanks to Mr. R. E. Westwood, the Manager of the Frodingham Ironstones Mines Ltd., for his valuable assistance in the preparation of this article.

Monthly Report of the Production of Iron and Steel in Canada, January, 1921

Prepared Under the Direction of
S. J. COOK,
Chief of the Mining, Metallurgical and Chemical Division, Dominion Bureau of Statistics, Ottawa.

Prefatory Note:—The present bulletin is published by the Bureau of Statistics in continuance of the service provided for many years past by the Mines Branch of the Department of Mines. A few changes have been inaugurated, notably the reporting on a monthly basis instead of quarterly; and the record of pig iron production by grades, which formerly was only shown in the annual report. All quantities have also been reported in gross tons of 2,240 pounds, whereas formerly the figures of pig iron and steel production were always reported in short tons. The thanks of the Bureau may be here expressed to the operators who have, without exception, promptly furnished the data necessary for the preparation of this report, and assurance may be given that no effort will be spared to make reports on iron and steel statistics for Canada comprehensive and in every way possible, adequate to the requirements of the trade.

The delay in publishing the present Bulletin has been due to the fact that the decision to issue a monthly report was only reached at the end of March, and as a consequence, returns for the months of the first quarter were all collected during the month of April. Reports for the months of February, March and April will follow this publication immediately, and beginning with the record for the month of May, prompt issuance of the Monthly Report of the Production of Iron and Steel in Canada,'' may be expected.

Pig Iron and Ferro-Alloys.

With only seven blast furnaces operating in Canada during January, out of a total of twenty furnaces installed, the total production of pig iron, exclusive of ferro-alloys was the lowest on record since 1904, and amounted to only 41,249 long tons of which 28,326 tons were made for the use of the firms producing, and the remainder or 12,923 tons for sale.

The 28,326 tons made by firms for their own use was produced by the basic process, using coke. Of the 12,923 tons made for sale, 137 tons was basic, 3,027 tons foundry, and 9,759 tons was reported as malleable.

The entire production of pig iron above recorded was made in blast furnaces there being no output during the month of low phosphorus pig from electric furnace plants. Blast furnaces were operated in January at Sault Ste. Marie, Midland, Port Colbourne, in Ontario, and at Sydney in Cape Breton.

Spiegeleisen was produced from the blast furnaces at Sault Ste. Marie and ferro-silicon in the several grades (15 p.c., 25 p.c., and 50 p.c.) was made in Ontario at Welland, Niagara Falls, Chippawa, and Hamilton. The total production of spiegeleisen and ferro-alloys during the month was 5,284 long tons.

The production of pig iron and ferro-alloys during January is shown in the following table:

	Made in Blast Furnaces (Tons of 2,240 lbs.)		
	For Maker's own Use.	For Sale.	Total Production.
Pig Iron—			
Basic	28,326	137	28,463
Foundry	......	3,027	3,027
Malleable	......	9,759	9,759
Total	28,326	12,923	41,249

Ferro-Alloys—Total production, 5,284 long tons.

No. of blast furnaces—	
Active at end of month	7
Idle at end of month	13
	20

In order that the value of the current figures regarding the output of pig iron may be studied in relation to data for previous years a table has been prepared in which the average monthly production is shown for the ten-year period from 1907 to 1916, inclusive, and the actual production by months for the years 1917 to 1920, inclusive. This table will be kept up to date in subsequent issues of this report.

AVERAGE MONTHLY PRODUCTION OF PIG IRON IN CANADA, 1907-1916.
(In 1,000's of Long Tons).

Year.	Monthly Average.
1907	48
1908	47
1908	56
1910	60
1911	68
1912	75
1913	84
1914	58
1915	63
1916	87

TOTAL PRODUCTION OF PIG IRON IN CANADA BY MONTHS, FROM 1917 TO DATE.
(In 1,000's of Long Tons.)

Month.	1917.	1918.	1919.	1920.	1921.
January	80	66	93	73	41
February	75	70	78	64	..
March	93	86	82	69	..
April	99	93	83	77	..
May	97	94	74	87	..
June	89	92	59	80	..
July	83	98	54	84	..
August	90	86	60	93	..
September	90	85	51	94	..
October	92	96	50	105	..
November	87	95	65	94	..
December	78	106	70	54	..
Total	1,044	1,067	819	974	..
Monthly Average	87	89	68	87	..

When the data given in the foregoing tables are plotted in the form of a curve, and the average daily production of pig iron in the United States is similarly recorded, the two curves are found to be practically parallel, the average daily United States production being somewhat higher than the Canadian monthly average. The close relation between the iron industry of Canada and that of the United States is very strikingly presented in this way.

Steel Ingots and Castings.

The decline in production noted in the pig iron industry is reflected in the steel industry, the output of steel ingots and castings in Canada during January amounting to only 40,058 long tons. This constitutes the lowest record since 1904.

Practically the entire production of steel ingots was made for use in further processes of manufacture by the producing firms only 371 long tons being made for sale. By far the greater part of the steel ingots was made in basic open hearth furnaces, the amount credited to this source being 36,410 tons.

Acid open hearth production amounted to only 107 tons while a total of 393 tons of ingots was made in electric furnaces.

Direct steel castings produced during the month amounted to 3,127 tons, of which 2,515 tons were made directly for sale. Most of the output came from electric furnaces, and the major part of the remainder from basic open hearths. Small quantities were made by the acid process, and some 200 tons in Bessemer converters.

The totals for the month by classes and grades are shown in the following table:

Kind.	Quantity made, in Tons of 2,240 Lbs. For own Use.	For Sale.	Production.
Steel Ingots—			
Open hearth (a) Basic	36,410	....	36,470
(b) Acid	107	....	107
Bessemer, (inc. all converters)	7	14	21
Crucible	....	....	....
Electric	36	357	393
Total steel ingots	36,560	371	36,937
Direct Steel Castings—			
Open hearth (a) Basic	57	957	1,014
(b) Acid	....	59	59
Bessemer, (inc. all converters)	77	155	232
Crucible	....	....	....
Electric	478	1,344	1,822
Total Direct Steel Castings	613	2,515	3,327

In order that comparisons may be drawn with pig iron production data, a table, similar to that given in the preceding section, has been made, in which the average monthly output of steel ingots and direct steel castings is shown for the years 1907 to 1916, inclusive, and the actual monthly figures are given for succeeding years. For convenience, the data show the production in thousands of gross tons (2,240 lbs.).

AVERAGE MONTHLY PRODUCTION OF STEEL INGOTS AND DIRECT STEEL CASTINGS IN CANADA, 1907-1916.
(In 1,000's of Long Tons.)

Year.	Monthly Average.
1907	53
1908	44
1909	56
1910	61
1911	66
1912	71
1913	87
1914	62
1915	76
1916	106

TOTAL PRODUCTION OF STEEL INGOTS AND CASTINGS IN CANADA, BY MONTHS, FROM 1917 TO DATE.
(In 1,000's of Long Tons.)

	1927.	1918.	1919.	1920.	1921.
January	117	130	107	92	40
February	108	124	90	84	..
March	136	141	100	97	..
April	125	149	75	93	..
May	139	136	69	90	..
June	122	148	68	91	..
July	124	147	666	94	..
August	130	532	54	165	..
September	135	149	60	99	..
October	144	164	66	111	..
November	141	116	82	97	..
December	139	105	87	56	..
Total	1,558	1,681	924	1,109	..
Monthly Average	130	140	77	92	

Iron and Steel Institute of Britian

Important Papers at Annual May Meeting.

(Digest by an English Correspondent.)

At the annual meeting of the Iron and Steel Institute in London papers of even more than usual interest and of an international character were read and discussed. The readers of the papers not only included scientists and prominent iron and steel men from all parts of the United Kingdom, but also experts from Sweden and Japan. The subjects dealt with were of great variety and importance, and amongst them one of the most practical was that by S. H. Fowles on the cleaning of blast-furnace gas.

The Cleaning of Blast Furnace Gas.

Blast-furnace gas plant had been the subject of special study by German engineers before the War, and in consequence gas plants which were in course of construction in England in August 1914 were left in an unfinished condition. This was the case with the plant described in Mr. Fowles' paper, which was in course of erection at Jarrow-on-Tyne. It was necessary in these circumstances for the English engineers to complete what the Germans had left unfinished, and in some cases this had to be done without any data, but the experience thus gained, the improvements subsequently made, the changes in practice which followed, and further additions and improvements, placed the British in an equal or possibly superior position in this branch of engineering to that occupied by their German competitors.

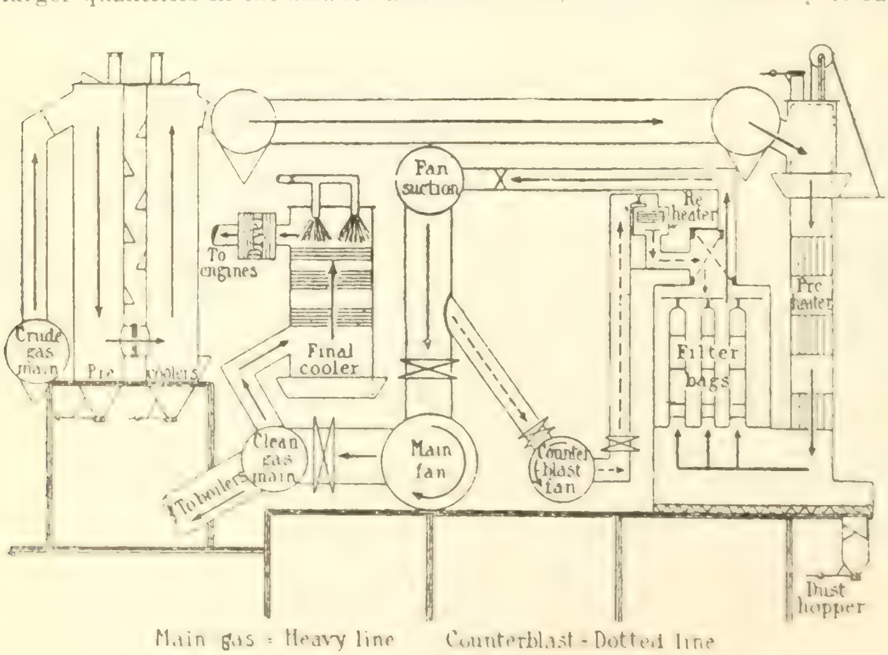
The particular plant described was estimated to be capable of cleaning gas to develop about 27,000 horsepower from crude waste gas. It ran continuously for eighteen months with a 20 per cent to 30 per cent overload, and was an important factor in increasing the munitions supply of the works where it was installed.

In this design of plant, the gas, laden with dust and moisture, passes from the furnace tops into large cylindrical dustcatchers, where about one-fifth of the larger dust particles is deposited. Potash, which is so important a product for use in modern agriculture, is present in small quantities in this larger dust, but in much larger quantities in the smaller and finer dust, which is carried by the gas through a zig-zag main to the cleaning plant, where the gas is finally divested of its dust and of most of its moisture.

Very little variation was found in the constitution of the gas, so that the engines could be set to give good running and constant load. The average temperature of the gas leaving the furnace was from 500 to 800 deg. Fah., dropping to about 500 deg. F. in the zig-zag main, which is about 8 feet in diameter. The alternate changing of the direction of the gas in this main causes the heavier particles of dust to be deposited and the temperature of the gas to be reduced.

In the illustration of the plant, main gas-passages are shown in heavy line, and counterblast in dotted lines. From the crude main, large uptake-mains convey the gas past butterfly baffles to the top of the dry coolers, which have four annular tubes passing vertically through them. It was intended for the air to take up heat from the gas and to cause a continuous flow of air up the tubes owing to the increased air-temperature, but as the hottest gas enters at the top of the coolers and has a downward path, the circulation was partly destroyed. An arrangement of water-sprays was made down the whole length of the tubes, and a considerably greater cooling effected. The drop by air was 15 deg. C., while the drop by water was 40 to 60 deg. C. Subsequently much better results were obtained by forced air-cooling in these tubes.

The gas passes from these dry coolers to wet coolers of the same diameter and length but with no inner tubes, and fitted with two rows of internal sprays. The gas takes an upward path, and the coolers were designed for the water to cool the gas and drop a considerable amount of dust owing to the dust becoming laden with moisture. This was wrong, as the dust particles are very small and contained much potash, which was carried away by the washing, because about 6 per cent. of the water introduced into the coolers was carried on by the temperature and velocity of the gas and the dew point of the gas considerably raised, also it was necessary to raise the gas to a higher temperature in the



Sketch of Plant for Cleaning Blast-Furnace Gas. (From S. H. Fowler's paper before the Iron and Steel Institute.)

pre-heater, before entering the bags to avoid moisture deposit, and there was condensation in the dust hoppers with reduction of percentage of potash in the dust. There was also spontaneous combustion of the dust, caused by the moisture coming into contact with the lime, and small particles of coke and carbon remaining in the dust.

Internal water is condemned, and all available external cooling resorted to. Ideal operating conditions are to lower the gas to a safe point, to drop say 80 per cent to 90 per cent. of the moisture content, and then to reheat the gas so as to allow it, on leaving the fans and being put on to the clean-gas main for service, to be not lower in temperature than when leaving the coolers, otherwise the moisture may be dropped.

The temperature of the gas-house containing the filter-bags should not be below the dew-point of the gas, or condensation will occur inside the boxes. Much information is given in Mr. Fowles' paper with regard to methods of calculating the dew-point and tests connected with it.

The correct hygrometric operation is of the greatest importance for proper results to be obtained, and it is now possible to get a dew-point with blast-furnace gas as low as 59 deg. Fah. This is due to the complete abolition of internal water-cooling, and a very low temperature of gas leaving the coolers.

The lower the temperature at which the gas is taken to the coolers, under dry conditions of cooling, the more moisture will be deposited. This is assisted by the coolers being provided with baffles on the incoming side, and the operation of all these baffles is simultaneous from inside the gas house. This enables the coolers to be kept under a very slight suction from the main fans, the maker's practice having been departed from, and instead of atmospheric pressure being maintained at the pre-heater bottom, it has been applied to the cooler outlet main. While this slightly increases the fan suction on the bags, the filtering of the gas is carried out under better conditions, and the fan suction is generally 1½ inches below the maker's figure when the plant is working on 20 per cent. overload. It has been proved in practice that the method should be to draw the gas through the filter-bags and not to push it through by a heavy crude-gas pressure. This considerably increases the life of the bags.

The counterblast quantity which is continually being cleaned and blown through the bags to remove the dust from their inner surface is of great importance. The maker's figure was 15 per cent of the total gas cleaned, but it was shown that this could be reduced to 8 per cent, which increased the life of the filter-bags, improved the conditions of the operating staff, and reduced the power consumption of the fans.

It is important that waste gas and heat should be used at the maximum efficiency, and this can be done in the internal-combustion engine, if satisfactory gas-cleaning plant is installed to provide clean dry gas for the engines. Gas-cleaning plants are of three main types, of which the first is the wet process. With this system the gas will be fully saturated, which will result in higher maintenance costs on the engine. With the electrostatic process of gas cleaning, capital costs and running power costs are high, but the gas after cleaning contains the whole of its sensible heat. The gas will, however, require further cleaning to be really fit for internal-combustion engine consumption.

The dry process of cleaning stands between the dry-hot and the cold-wet systems, and is considered to produce suitable engine-gas and to be free from the disadvantages contained at present in the other systems.

Blast Furnace and Cupola Slags.

J. S. Fletcher dealt with the composition of blast-furnace and cupola slags and with graphical methods of determining their constitution. His paper collated the data of many workers who have carried out research on slags. Slags are now generally recognised as being more or less complete solutions of acid and basic oxides, their oxygen contents, depending upon the union of that gas with the metals or metalloids present, determining the acid, basic or neutral character of the slags.

In blast-furnace practice the natural gangues of an ore are usually most heterogeneous and varied in character. Percolations of gases and of liquid material may have filled in the interstices of the porous portions of the ore mass, whilst in other areas the primary homogeneous character of persists longer. When an ore is reduced, the melted gangues are far from uniform in composition and may contain free and infused refractory oxides.

Hence the difference in the character of the streams of slags as they flow through the lower portions of the blast-furnace column, and the lack of homogeneity of the commingled slags when they first reach the hearth. The problem of smelting ores of similar general analysis but of vastly differing physical composition is bound up with the variation in the viscosities of the slags descending through the hearth or lower portion of the boshes.

It is becoming incleasingly necessary, if a true explanation of the reactions between slags and metals is to be arrived at, to ascertain the most probable composition of the liquid slags at the time such reactions are in progress. Although the mineralogical character of the cold slags is of much use in slag research there is a great danger lest it should be concluded that the many crystalline transition-products discovered in the cooled slags were present when they were more or less actively molten. Mr. Fletcher is undertaking further researches on similar lines in an endeavour to represent in graphic form the changes which take place in converter, puddling and open-hearth processes, and the results of these investigations will be described to the Institute at a later date.

Tungsten Tool Steel.

In an important paper extending to nearly ninety printed pages S. N. Brayshaw described some researches which he has carried out with regard to the prevention of hardening cracks and the effect of controlling recalescence in a tungsten tool-steel. The steel contained about 1.1 per cent of carbon and 0.8 to 0.9 per cent of tungsten. The changes that occur during the halts in heating and in cooling were investigated by means of a large number of bars, which, after soaking for various periods of time at temperatures near the critical points, were quenched in water.

The condition of the steel after quenching showed the progress of the change, and some of the results suggest that, both in heating and in cooling, the changes Ac. 1.2.3 and Ar. 1.2.3, take place in stages which may be separated one from another, if sufficient time is allowed for the process.

A second series of bars similarly heat-treated, was cooled in sand instead of being water-quenched, and all these sand-cooled bars were finally hardened by one standard process. These bars lengthened or shortened on hardening, in response to the maximum temperature

of the previous annealing, and to the progress that had been made in the slow recalescence during that annealing. The behaviour of the hardened bars under bending stress was also found to have been determined by the heat treatment prior to the hardening. Light is thrown upon the subject by a comparison between those water-quenched bars referred to above and the bars which were sand-cooled from the heat-treatment and then hardened.

The tendency of the steel to crack in hardening was correlated to the various results from bars by means of a series of milling-cutters purposely made of a design extremely difficult to harden. The milling cutters were machined out of blanks which had been heat-treated together with the bars. After the machining the cutters all underwent the same standard hardening without any intervening process.

The resulting cracks were found to occur in reasonable sequence with the heat treatment and with the results from the bars. When sufficient time was allowed for the heat treatment, within a certain range of temperature, the steel reached a condition in which the liability to crack in hardening was greatly reduced.

Additional information produced by the research showed that there was a remarkable uniformity in the modulus of elasticity of the hardened bars, which differed greatly in other respects. Cutters which broke badly in hardening were generally made from blanks in which the ratio of the Brinell figure to the Shore figure was comparatively high. Progressive changes in length on successive days after hardening are referred to in the paper, and it is suggested that a standard hardening test should be devised and specified for each given steel.

Estimating Sulphur in Steel.

T. E. Rooney of the National Physical Laboratory described some work which was undertaken with the object of ascertaining whether it is necessary to anneal the drillings used in the volumetric estimation of sulphur, in order to obtain results which are in agreement with the results obtained by standard gravimetric methods.

The investigation showed that this annealing is unnecessary with ordinary commercial carbon-steels in the great majority of cases, unless the drillings have been stored for some time and incipient rusting has taken place, or unless the presence of elements like titanium is suspected. Annealing the drillings may be necessary with steels low in manganese and containing chromium, which are liable to contain oxides which may form a eutectic with the sulphide.

Cupric Etching Effects produced by Phosphorus and Oxygen in Iron.

In this paper J. H. Whiteley described the progress which had been made with some investigations on the cupric etching effects produced by phosphorus and oxygen in iron. He showed that differences in phosphorus content of less than 0.02 per cent in adjacent parts of otherwise pure iron can be readily discovered by means of the cupric reagents. As the difference is increased, at any rate up to 0.15 per cent, the contrast becomes more and more pronounced. These differences were produced by first phosphorising strips of the iron with phosphorus in hydrogen at 1000 deg. C. and then welding, in hydrogen or other gas, a pile made up of alternate strips of phosphorised and unphosphorised material.

Attempts to produce in a similar way an unequal distribution of oxygen, which could be detected by the cupric reagents in the same manner as that of phosphorus have failed. When oxygen was present, white resist-lines were formed only at the weld-junctions, but these resist-lines were not formed when the unoxidised iron was welded in dry hydrogen.

Two methods of obtaining an unequal oxygen content were employed, in the first of which pure iron was soaked in its own oxide at a high temperature and then welded with the unoxidised material, and in the second method highly-oxidised iron was reduced in hydrogen and then welded with the original metal at a low temperature.

Cause of Quenching Cracks

K. Honda, T. Matsushita and S. Idei, of Japan, dealt with the cracks caused by quenching high-carbon steels in water. They demonstrated that in a quenched steel a certain amount of austenite is generally present intermingled in martensite. The amount of this austenite increases as the quenching temperature rises. In small pieces of steel the periphery is harder than the central portion only when the quenching is very soft. In a moderate quenching the hardness is everywhere nearly equal, but in a hard quenching the periphery is always softer than the interior. This is explained by the presence of arrested austenite in martensite.

The quenching cracks in small pieces of steel occur when the hardness in the central portion is much greater than in the periphery. The cause of the crocking is attributed to the stress caused by the difference in the specific volume of austensite and martensite, as owing to the specific volume of the former being smaller than that of the latter the central portion exerts a great tangential tension on the periphery.

As the difference in specific volumes increases as the temperature falls, the cracking usually takes place when the temperature of the quenched specimen approaches the room temperature. In a hard quenching the hardness generally increases with the lapse of time, owing to a gradual transformation of the arrested austenite to martensite.

In the case of a large specimen, cracking may take place at the Al range, and also near the room temperature. The cracking at the high temperature is chiefly caused by the stress due to the structural difference between the inner and outer portions, pearlite and austenite, just below the Al point, and the cracking at the room temperature is due to a similar stress as in the small specimens.

Other Papers.

Other papers were read at the meeting, which was held on May 5th, and 6th, by Dr. J. E. Stead on the "Solid solution of oxygen in iron," by H. Brearly on "The welding of steel in relation to the occurrence of pipe, blow-holes and segregates in ingots", by Dr. J. N. Friend on "The protection of iron with paint against atmospheric corrosion," by W. E. Hughes on "Slip-lines and twinning in electro-deposited iron", by Dr. A. Westgren of Sweden on "Roentgen spectrographic investigations of iron and steel", and by H. T. Ringrose on the "scientific control of combustion."

WORKMEN'S COMPENSATION IN NOVA SCOTIA DURING 1920.

The report of the Workmen's Compensation Board of Nova Scotia for 1920 shows that the improvement in the number of fatal accidents disclosed by the 1919 figures has not been maintained. A comparison with previous years, after deduction of fatalities in two coal-mine explosions and a lumber-camp fire, is as under:

	1917	1918	1919	1920
Fatal accidents	146	185	59	81
Deduct disasters	65	105	..	..
	81	80	59	81
Number of Coal-mine fatalities, included in above	97	126	21	28

The total number of compensable accidents in 1920 was, so far as reported, 5649, a notable increase over previous years, particularly in cases of temporary disability, as is shown by the following table:

	1917	1918	1919	1920
Fatal Accidents	146	185	59	81
Temporary disability	4,504	4,504	4,640	5,374
Permanent disability	187	242	250	194
	4,837	4,931	4,949	5,649

The cumulative tendency of compensable accidents is illustrated by this comparison.

Assessment rates were generally adjusted downwards, the Nova Scotia Board having taken no chances in making assessments in the earlier stages of the operation of the Act. Some of the principal adjustments made were as follows:

	Assessment Rates. 1918	1919	1920
Coal mining	$4.00	$3.00	$2.20
Steel & Iron Manufacturing	1.90	1.50	1.00
Building	2.00	1.50	1.00
Stevedoring	4.00	3.00	1.00
Steam Railways	4.50	2.00	1.00
Lumbering, etc.	4.20	4.20	3.80

The cost of administration grows steadily, the ratio of expenses to the total assessments levied being in 1920 8.6 per cent, comparing with 5.76 per cent in 1919, 3.66 per cent in 1918 and 2.58 per cent in 1917. While some growth in this ratio was to be expected the figures of 1920 seem to be excessive.

The investments in the hands of the Board at the end of 1920 total $3,119,026, comparing with $2,233,026 at the end of 1919, all, with the exception of $245,000 of Province of Nova Scotia bonds, being government war-loan securities.

The particulars of nationalities of injured workmen shows that 4,425 of these out of a total of 4,949, or 90 per cent, were British. This confirms the general belief in Nova Scotia that not more than 10 per cent of the industrial population is non-British. The average age of injured workmen is given as 34 years, with an average weekly wage of $18.57. The number of cases of injury developing sepsis was, in 1919, 122 or 2.6 per cent, which compares with 2.3 per cent in 1918 and only 1.6 per cent in 1917. The increase is in the wrong direction and is rather surprising.

A number of enlargements of the scope of the Act were made in 1920 that will increase the expenditure. Injured persons, from the 1st. of January, 1920, became entitled to free medical aid for a period of thirty days from the date of disability.

The cost of medical aid for the first year was $50,789, but this amount does not represent anything like the full cost of medical aid under the Act, as the workmen of the Dominion Coal Company, and of practically all the other coal companies, of the large steel companies, and many other industrial concerns are furnished aid under schemes allowed under the Act. It is stated the medical aid conditions at the coal-mines are not in the opinion of the Board satisfactory, and that conferences are to be held between the operators, the workmen and the Board to formulate new arrangements.

From October 1st, 1920, the allowances to widows and children are increased as follows:

a. Widows from $20 to $30 per month.

b. Children (where there is also a widow) from $5.00 to $7.50 per month.

c. Children (where they are the only dependents) from $10 to $15 per month.

These increases are retroactive, applying to accidents happening in the previous three years and nine months, which necessitated adding a capital sum of $335,748 to the pension reserves, and increased assessment rates in some industries, and prevented their being lowered in others.

The industry where least has been done in the way of accident prevention is the lumbering trade, and the Board signifies its opinion in this respect by the very assessment rate. The Accident Prevention Association is stated to be doing good work, and a sum of $8,320 was expended out of the Accident Fund in 1920 in forwarding the educational campaign of this Association.

Wages paid in industries coming under the Board totalled $73,000,000 in 1920, some of the chief items being as follows:

Coal Mining	$21,170,000
Steel and Iron Manufacture	9,350,000
Steam Railways	2,090,000
Lumbering and Sawmills	5,800,000
Building (general construct.)	3,570,000

The Board states that it has not incurred or paid one cent for legal fees since the Act came into force.

FRENCH STEEL COMPANIES COMBINE.

Through the office of the commercial attaché at Paris it is learned that three of the largest steel corporations in France have recently combined. The principal company of the new combine is the Société Anonyme des Forges et Aciéries du Nord et de l'Est, the capital of which is to be increased from 46,000,000 to 86,000,000f. It will absorb the holdings of the Société des Forges et Aciéries du Nord et de la Lorraine and of the Usines Métallurgiques de la Basse-Loire. It is stated that the new company will control an ore domain with equipment for an annual production of 4,000,000 tons, and also six large French coal companies and important coal deposits in England as well as coke, cement and building material companies, rolling mills, foundries and casting plants.—"Chem. Met. Engineering."

Compressed Air Reservoirs in Ore Mines

JOHN S. WATTS, New Glasgow.

The economy gained by having a large reservoir for compressed air is well proved by the experience of those who are using them, although these are yet but few in number. The ease and cheapness with such reservoirs can be made in ore mines, will undoubtedly read to a much wider use in the future, and therefore, a few words on the main considerations that bear on their effective design will not be untimely.

The conditions and difficulties that have to be met, vary so greatly in each mine, that it will be impossible to state any empirical rules from which to calculate the various component parts of the system, but a fairly clear idea of what points must be watched for, can be best given by taking a hypothetical case, embodying the most difficult features that may be expected to arise.

Let us assume the following data. The consumption of air in the mine is at the rate of three thousand cubic feet of free air per minute, for a period of eight hours per day, and it is desired to use a small compressor running twenty-four hours a day to handle this demand.

The mine is handled through a slope, which is on a twelve per cent grade, and has numerous old workings which can be used for an air reservoir, by erecting suitable dams to block off the desired capacity.

The requirements for the reservoir system are, that we have an air-tight chamber for the air reservoir, of a cubic capacity to be determined later, and another chamber, or reservoir of equal capacity for a water storage, at an elevation above that of the air reservoir, which will give the water a head that will be equal to the desired maximum air-pressure.

The water reservoir may be either on the surface, or under-ground, as may best suit the available location for the air reservoir, the main consideration being that the water storage shall gain its capacity by large area, rather than by depth. The reason for this is that a deep reservoir would lose some of its head as the water-level falls, through the water passing into the air reservoir. The air reservoir should also be preferably shallow in depth for the same reason.

The arrangement will be more clearly understood by reference to the accompanying drawing, and the desirability of having both reservoirs low in height, will be clearly seen, by observing that "H" being the head of water when the air reservoir is full of air, and "h" the head when it is emptied of air, the loss in head is equal to the sum of the vertical heights of both reservoirs.

The maximum difference between the two heads, "H" and "h", must be less than what will be equivalent to the difference between the maximum and minimum air-pressures. That is, if we set the unloading valve on the air compressor to give a maximum air-pressure in the reservoir of one-hundred pounds, and the minimum useful air-pressure at the reservoir is say eighty-five pounds, we have a latitude of fifteen pounds, which is equal to a head of nearly thirty-five feet. The difference between "H" and "h", must therefore be less than thirty-five feet.

The head "H", must be that which will produce the maximum pressure of one hundred pounds, with the water level at "a", and the head "h", must be sufficiently over the minimum pressure of eighty-five pounds to get a delivery of water through the water-pipe connecting the two reservoirs equal to the delivery of air required from the air reservoir.

At the same time, if this pressure of eighty-five pounds is ample to operate the air drills, etc., a reservoir of a given capacity in cubic feet, will carry the load longer with a reducing pressure than it would with a constant pressure, because of the expansion of the air, consequent upon the falling pressure, so that this loss of head as the air becomes exhausted from the reservoir, is not an unmixed evil, if kept within the proper limits.

Considering now the capacity required in the air reservoir, we have to take care of a demand of three thousand cubic feet of free air per minute, which is equal to about 420 cubic feet of compressed-air per minute, or a total of $420 \times 60 \times 8 = 201{,}600$ cubic feet per day.

As the compressor is to run twenty-four hours per day, while the consumption of this 201,600 cubic feet occurs in eight hours per day, the reservoir must have a capacity of $201{,}600 \times 2/3 = 134{,}400$ cubic feet. This should be the minimum capacity, and it would be advisable, if possible, to have the reservoir somewhat larger, to be on the safe side, and to allow for a possible increase in the consumption of air in the future. A large reservoir will also hold the load during a short temporary stoppage of the compressor for minor re-

pairs, and for this purpose it is advisable to place a check valve in the main line between the air compressor and the air reservoir, to hold the pressure in the reservoir in case of a failure or stoppage of the compressor.

The water reservoir must hold enough water to fill the air reservoir, that is it must be of equal capacity, or at least equal to the reservoir capacity actually used. But for reasons of safety, it is well not to have it any larger than is necessary, as any failure of the water pipe or reservoir, would release this mass of water, and permit it to flow into the mine, hence the less this amount of water is, the safer it will be.

The next point to decide is the size of pipe required to convey the water between the water reservoir and the air reservoir. This pipe must be large enough to deliver an amount of water equal to the delivery of air expected from the reservoir during the peak load, or to the delivery of air from the compressor into the reservoir, when there is no air being used, whichever is greatest, and will be determined by the head available to overcome the friction.

In our example the largest delivery of water will be required when the air consumption is greatest, that is when 420 cubic feet of compressed air per minute is being used, of which two-thirds, or 280 cubic feet per minute, will be drawn from the reservoir. We must now study what occurs when the demand begins to withdraw air from the reservoir.

At the beginning of a shift, the air reservoir will be filled with air at say one hundred pounds pressure, and the head of water "H", will be 230 feet, or just sufficient to balance the air pressure. As air is withdrawn from the reservoir, this 100 pounds pressure will fall, as it is obvious that until the pressure falls there will be practically no appreciable head on the water to overcome the friction of the water in the pipe.

For reasons that will appear later, it is desirable to keep this water pipe as small in diameter as possible, and as the delivery is governed by the head on the water, which is the difference between the air pressure and the water pressure due to the static head, "H", we must decide on how low we can allow the air pressure to fall, before we will get the required volume of water flowing through the pipe to replace the air withdrawn.

As most air tools will function satisfactorily with eighty pounds pressure, we will take it that eighty-five pounds in the reservoir will be satisfactory, for the minimum pressure. If the difference between "H" and "h", is sixteen feet, the static water pressure at line "b", will be ninety-three pounds, leaving eight pounds pressure per square inch to overcome the friction of the pipe.

Taking the length of the pipe as 1800 feet, and the effective head as eighteen feet, (equivalent to eight pounds pressure) we have the head of water divided by the length of the pipe as .01, and referring to a table of deliveries of water through pipes, we find that for a delivery of 280 cubic feet per minute, we need a twelve-inch pipe.

To illustrate the necessity when the pipe is long, because of this drop in pressure, to keep a reasonable sized pipe, if the difference in "p" pressure were only three pounds, it would be necessary in the above example to use a fifteen inch pipe.

Whenever then the pressure in the reservoir begins to fall, water will commence to flow into it, slowly at first, but reaching to an equality with the air flowing out, whenever the pressure falls to eight pounds lower than that due to the head of water, that is to 93 pounds, when the water level is at line "a", and 85 pounds when the water rises to line "b".

So long as the maximum consumption of air goes on, the water will continue to fill the air reservoir, as fast as the air is withdrawn, holding the air pressure to the minimum given above.

Whenever the consumption of air ceases, or becomes less than the output from the compressor, the air compressor will force air into the reservoir, until the pressure becomes sufficiently higher than the water pressure to force the water back up the water pipe, and will continue to do so, until the air reservoir is filled with air at the maximum pressure, when the unloading valve on the compressor will stop further compression. This brings us back to the condition from which we started, and completes a cycle.

With a long pipe, as in our example, a certain amount of excess pressure will be needed to force the water back up the pipe, which should be calculated to ensure that it will not require too great a pressure in the compressor.

The delivery of air from the compressor, in our case, will be at the rate of 140 cubic feet per minute, requiring a velocity of the water in the twelve-inch pipe of three feet per second, and entailing a pressure of about three pounds to attain this velocity. The unloading-valve on the air compressor must be set to operate at 105 pounds, or such pressure as is needed to give 103 pounds at the air reservoir.

This high pressure will be needed only when the air reservoir is approaching the point where it will be filled with air, and can only occur for a short period of time.

Some form of automatic float-actuated valve is necessary to close off the water pipe where it enters the air reservoir, whenever the water reaches the low level, "a", to prevent the possibility of air being forced up the water pipe and wasted, after the reservoir is completely filled with air.

A similar valve is also required on the air-outlet pipe in the air reservoir, to prevent water entering the air lines, when all the air has been exhausted from the reservoir.

As mentioned above the water pipe should be kept as small in diameter as will admit of its fulfilling its purpose, mainly because of the large kinetic energy in the moving column of water, which energy must be absorbed to stop its flow, in the event of any sudden change in the air pressure.

Taking the example already worked out, we have a twelve-inch pipe, 1800 feet long, which will contain 1414 cubic feet of water, weighing 90,500 pounds, travelling at a normal speed of six feet per second. The energy in this mass of water will be

$$\frac{wv^2}{2\,g} = \frac{90500 \times 6^2}{2 \times 32.16} = 50{,}500 \text{ foot pounds.}$$

Under normal conditions with some air in the reservoir, this energy would be expended in raising the pressure of the air one or two pounds, but this excess pressure would be held, by the check-valve already mentioned, from coming on the air compressor.

If, however, through some failure in the air lines, the air pressure was to fall abruptly to atmospheric pressure, we would have the full head "H," on the water, which would raise the velocity of the water to about twenty feet per second, and would increase the energy to

$$\frac{90{,}000 \times 20^2}{2 \times 32.16} = 561{,}000 \text{ foot pounds.}$$

This is equal to the raising of 280 tons a height of one foot, and is quite capable of wrecking the reservoir, and permitting the whole contents of the water reservoir to enter the mine workings.

To prevent this, an automatic valve should be fitted, preferably in the upper end of the water line, actuated by the air pressure, which would protect the water pipe in the event of any serious drop in the air pressure.

BRITISH EMPIRE STEEL CORPORATION'S PRODUCTION.

The Sydney Plant has not been making steel during recent weeks, and one blast furnace has been making pig-iron, more as an outlet for coke than because the pig-iron was required. The new Kopper's ovens have been in partial operation, making a minimum quantity of coke and gas so as to keep the ovens in good condition. The present cokeoven installation of two batteries of 60 ovens each is being added to by a third battery of 60 ovens, making 180 ovens in all. Completion of the third battery is not being rushed.

The nail-mill, rod-mill and merchant-mill have been employed on single shift, and repairs have been under way to the blooming mill and open-hearth plant.

The Canadian National Railways have given the Steel Plant an order for 40,000 tons of rails at the price of $55.00 per ton, and it is expected that a start will be made on rolling these rails about the middle of June. One blast-furnace will be put in blast immediately, and the rail order is expected to give employment to the plant until the end of September.

The price awarded for the rails has necessitated a reduction in the steelworkers' wages of ten percent, which is in addition to a reduction of twenty percent made at the beginning of the year. There has been some reported disposition among the steelworkers to contest the latest reduction, but as the Government refused to consider a higher price for rails, and as the Company is unable to make ends meet at the awarded price without a wage reduction, the choice is between a limited amount of employment during the Summer or indefinitely continued idleness, and it is unlikely that any hitch will take place over the wage question.

At Sydney Mines the steel plant is idle, and has been for some months. Under prevailing business conditions there is no immediate possibility of resumption of steel production at Sydney Mines.

At New Glasgow production has been practically suspended for several months, but an order for rail accessories and fastenings in connection with the Sydney Plant rail-order has been given to the New Glasgow and resumption of work in some departments will take place.

The Eastern Car Company is partially employed, but no equipment orders have as yet been given by the National Rys. and the outlook for the remainder of the year is not good. The car-works has made some mine-cars for the collieries of the Corporation, and in future will take care of all the rolling-stock requirements of the railways and mines of the Corporation, which will be fairly heavy in the near future.

At Sydney, the Corporation has added a slag-crushing plant for the preparation of road-metal, and has completed an installation to make silica brick and fire-brick in the shapes and sizes required by the steel plant and coke-ovens, from locally-mined silica rock. More detailed reference to these additions will be found elsewhere in this and the July issue.

Stocks of ore and limestone are very large, both at the mines and on the stockpiles at the Sydney Plants, and curtailment of mining operations in Newfoundland may be looked for at an earlier date in the Summer months than usual.

BRITISH TRACTORS TO ENTER CANADIAN MARKET.

Increased production of British agricultural machinery and tractors through the cultivation of foreign markets is being urged in England as a means of bringing prices to a level that would permit successful competition with foreign made products, according to information just received from the London trade representative of the Guaranty Trust Company of New York. In this connection, the report says, arrangements have already been made to produce one well known British tractor on a large scale and market it in Canada on a systematic plan. Canada is the world's largest market for tractors and up to the present it has been practically controlled by the United States, and the selling scheme of this British tractor will be planned especially to meet American competition. A branch factory will be established in Montreal with an adequate stock of spare and repair parts and special arrangements will be made for service, a factor which has been more or less neglected by British firms in the Canadian market.

In harvesting machines, the British are experiencing strong competition from Germany. British manufacturers hope to reduce their prices in 1922, but are unable to do so earlier owing to the heavy stocks of high priced goods on hand. There is a good demand from Manchuria for bean harvesters and threshers of about four to eight horse-power, suitable for soya beans. There is also strong German competition in dairy appliances. Makers of sugar machinery are, however, receiving good orders from Java and Cuba.

The automible market is quiet and prices are still falling, though there is a distinct improvement in the demand for commercial cars.

Guaranty Trust Co., New York.

An example of the adaptation to circumstances made possible by the consolidation of the coal companies in Nova Scotia is the recent shipping of two cargoes of coal from Pictou Harbour, N.S. to St. Lawrence points. The coal was from the Acadia Coal Company's mines at Stellarton, and was shipped in the "Watuka" and "Volunda" two steel-freighters of about 2,700 tons dw. both built by the Nova Scotia Steel Company at New Glasgow. It is many years since the Pictou loading pier was used for shipment of coal. The British Empire Steel Corporation possesses coal-loading plants at Sydney, North Sydney and Louisburg in Cape Breton Island, and at Pictou, Parrsboro' and Halifax on the Mainland, and it can send coal from mines in Cape Breton, the Pictou County field, or Springhill Mines, as occasion may require, for loading at the several ports to minimise the length of the rail-hauls and to suit the convenience of the available steamers in regard to times of arrival and point of destination. A central despatching office for the freighting fleet will control all ship movements. Wireless telegraphy is proving to be an indispensable aid to work of this kind.

The Work of the Honorary Advisory Council for Industrial and Scientific Research

When the Research Council Bill, now enacted, was before the Houses of Parliament, a statement of the work done and planned by the Advisory Council was given to each member of parliament. By the courtesy of a member of the Council the "Journal" has received a copy of the statement, which is herewith reprinted insofar as it pertains to matters of interest to the mining industry. In addition to these matters, the Council is investigating the prevention of rust in wheat, the most suitable method of reforestation in Canada, the prevention of the destruction of concrete by alkaline waters peculiar to the West, the breeding of foxes, utilization of fish-waste, the separation and liquefaction of helium, and a number of other matters, such as fog signalling, materials for insulation of high-voltage electric currents, sulphite-liquor waste, vanadium ores, vitamines, bacterial content of cream and butter, and more efficient methods for heating houses.

The Constitution of the Research Council.

The Research Council consists of eleven gentlemen chosen from the Universities, the Engineering Profession and the Industries of the Dominion, who have been appointed to advise the Government with reference to the best means of applying the great discoveries and advanced methods of modern science to the further utilization of the natural resources of the Dominion of Canada, to the development of new industries in the Dominion and to the extension of those which already exist.

With the intense competition which exists in the industrial world at the present time and which promises to become even keener in future years, those nations which have the resources of science at their command will have, of course, an enormous advantage over those which have not.

This fact has already been so clearly realized by Great Britain, France, the United States of America, Japan, the Commonwealth of Australia and the Dominion of South Africa, that each of these has established a Research Council similar to that now in existence in Canada for the purpose of applying the methods of Science to their industries.

In order that its work may be made efficient over as wide a field as possible, the Research Council has secured the active co-operation of no less than 109 of the leaders of science and industry in Canada who are organized into Associate Committees.

All these gentlemen, with the single exception of the Administrative Chairman of the Research Council, give their services to the Government without payment.

The Manner in Which the Research Council Carries Out Its Work.

The council has been in existence a little over four years. The first year and a half of this period was devoted to the development of its organization, and to a thorough study of the whole field of Canadian resources and industries.

This study showed that certain great problems now face the Dominion which must be solved if the country's industrial development is to be furthered or even maintained.

The council then proceeded to make a detail examination of each of these problems, calling in for purposes of consultation the most expert advice that could be secured. When it was convinced that a problem was one which might be solved, it selected a group of experts, or sometimes a single individual and appointed them to carry out the work, arranging at the same time for the provision of the funds necessary for this purpose. In this way the various investigations were carried out by the men most competent to undertake them and under conditions most favorable for success.

Fuel Investigations.

The fuel problem is one of the most important which Canada has to face.

Enormous sums of money are paid to the United States every year for coal.

All the coal used in Central Canada comes from the United States, and should this supply—for any reason —be cut off even for a single winter, it is well to contemplate what would happen to the people and industries of this part of the Dominion.

The first investigations, therefore, undertaken by the Research Council dealt with the provision of a supply of fuel from Canadian resources to replace that imported from the United States. Tht two following investigations were arranged to this end.

The Utilization of the Peat Deposits in Canada.

The Department of Mines reports that there are at least 37,000 square miles in Canada covered by peat bogs. These bogs are from 5 to 10 feet deep. Many of them lie in Central Canada where there is no coal. About 1-8 tons of air dried peat are equal to one ton of coal for heating purposes. One square mile of peat bog contains an amount of peat equal to 430,000 tons of coal. Attempts have been made at intervals for the past sixty years or more to utilize this Canadian peat, but without success. The best results were obtained by the Federal Department of Mines in their operations a few years ago on the great peat bog at Alfred on the line of the Canadian Pacific Railway between Ottawa and Montreal.

The Research Council after a careful study of the situation decided that it should be possible to cut down the cost of producing air dried peat, and thus put this material on the market at a price which would make it readily saleable. They therefore arranged with the Dominion Government and the Provincial Government of Ontario for the appointment jointly of a Peat Commission, and for the provision of grants for the carrying out of the work of the Commission in question.

The Peat Commission decided to undertake work at the Alfred bog, and have carried on operations there for two summers. They have used a machine similar to that formerly supplied by the Department of Mines, and have designed a new machine of greater efficiency.

They have succeeded in greatly reducing the price of manufacture.

Last summer, they made 5,900 tons of excellent air dried peat at this bog. This was sold under commercial conditions in the city of Ottawa, and in some 25 smaller cities and towns of Central Canada. It was found to meet with a ready market everywhere in competition with coal, and ten times as much could have been sold had it been possible to produce it. Offers were received from individual companies

to take the entire output of the bog. The peat was sold at varying prices which however in every case left a good margin of profit.

The Peat Commission believe that a still further reduction in the cost of production may be made by further improvements in the machines now in use, and in order to bring their work to a final conclusion with a view to the delivery of peat at the lowest possible cost to the community they have asked the respective Governments for a continuation of their grant for another season.

If this is done there is every reason to believe that a great new and profitable industry will in the immediate future develop in Canada as the result of the work of this commission.

The Briquetting of the Low Grade Lignites of South Eastern Saskatchewan.

The only fuel which occurs in Eastern Saskatchewan and Manitoba is the low grade lignite which falls to pieces when mined and has, therefore a very restricted use. This fuel, however, occurs in enormous amount.

The Research Council took up the question of the manufacture of a high grade fuel comparable to anthracite from the abundant supplies of this low grade material. The deposits were visited and a complete study of the whole subject was made with the help of Geologists and Engineers from the Department of Mines, the Commission of Conservation, as well as with the help of other experts who were called in for consultation. This study embraced an examination of the character and extent of the lignite deposits, the possibilities of carbonizing this fuel and the best method of briquetting, the question of suitable binders for the briquettes and all other details of manufacture. Extended experiments were then made on carload lots of the lignite, which resulted in the production of excellent high grade fuel in the shape of small briquettes which are clean, easily handled and convenient to burn. An extended test just completed of this briquetted fuel in comparison with the Pennsylvania anthracite imported into Canada, shows that the briquetted fuel has a heating power practically identical with that of anthracite coal.

Consignments of this fuel have already been supplied to the Prime Minister of Canada and the Premiers of the Provinces of Manitoba and Saskatchewan.

The Research Council, in order to carry out this research, arranged with the Federal Government and with the Provincial Governments of Manitoba and Saskatchewan, for the joint establishment of a Fuel Research Board, under the Chairmanship of a member of the Research Council, and for the provision of adequate grants to enable the Board to build a commercial plant at Bienfait (near Estevan) Saskatchewan, capable of turning out 100 tons of briquetted fuel per diem, the raw material being mined in the immediate vicinity. This plant is now nearly finished, and will be manufacturing this new briquetted fuel next June. The whole plant would have been in operation last August as originally scheduled, had it not been impossible — owing to the conditions in Canada during the past year — to obtain delivery of the necessary machinery for the plant.

There is every reason to believe that this fuel can be placed on the market at a price considerably lower than is now paid in Manitoba and Saskatchewan for anthracite imported from the United States, and that another large and profitable industry will be started in Canada which will at the same time supply the people of this portion of the Dominion with a fuel made in Canada, thus doing away with the necessity of sending millions of dollars to the United States each year for the purchase of coal in that country.

The Use of Canadian Iron Ores in the Place of Iron Ore Imported from the United States.

Realizing that Canada is paying annually millions dollars for steel products purchased in the United States, and that steel plants in the interior of Canada have been dependent on the United States for their supplies of iron ores, the Research Council has, through committees, been making a thorough investigation of the iron ore resources of the country. These researches have been conducted along two lines (one) to determine if our low grade ores could be treated by beneficiation so that they can be used commercially in blast furnace practice, and thus relieve our furnace operators of importing their ores from the United States, (two) investigation of electric smelting methods of our low grade ores.

The committees have accomplished much, and as a result of their investigations have made a preliminary report to the Research Council. They are convinced that Canada possesses large bodies of iron ore which however requires treatment or beneficiation to put it in shape for commercial reduction to pig iron, and also that the time has arrived for this work to be undertaken. The decreasing iron value or content of the Minnesota ores, proportionately increases the value of Canadian ore, and promises to create another Canadian industry in which our transportation systems will take part.

It is hoped during the present year to arrange for a commercial test under actual blast furnace operation of a sufficient quantity of Canadian low grade ores, 10,000 to 15,000 tons, to determine the value and usability of our enormous ore deposits.

Training Research Workers.

By the foundation of Bursaries, Fellowships and Studentships, tenable in Canadian Universities, provision is made each year for the training of a certain number of young graduates who have shown ability and promise in the methods of scientific investigation, thus providing workers for the prosecution of research in the Dominion.

Education of the Public in the Necessity of Research for the Advancement of Canadian Industries.

Several members of the Research Council have at various times since its establishment visited the important centres of industry in all parts of the Dominion and addressed Boards of Trade, Canadian Clubs and other important and influential bodies, on the value and importance of Scientific Research and the plans of the Government of Canada to meet their needs.

The Need for a National Research Institute in Canada.

While many researches must necessarily be carried out in the field or be located at certain special centres, and while others can with advantage be carried on at Canadian Universities, there is a great body of research work which now needs to be carried out in connection with the various industries of the Dominion which is too varied, too elaborate and too technical to be well done in our Universities which are primarily teaching institutions.

The Research Council believes that the time is now ripe for the erection of a National Research Institute

under the management of the Research Council in which the necessary laboratories and appliances for scientific and industrial research — with an efficient staff of workers — will be provided. Such an Institute would be equipped and ready to undertake the study and solution of the great number of special problems and difficulties which present themselves in all advancing industries, and the solution of which is necessary to the highest industrial success. The Research Institute would render to Canada and Canadian Industry the services which are now being given to the Industries of the United States by the National Bureau of Standards at Washington and the Mellon Institute at Pittsburg, although these are planned on a much larger scale to meet the need of a much larger population.

The Bureau of Standards which is maintained by the Federal Government at Washington, employs about three hundred scientific workers and handles the greatest diversity of problems. It tests papers, textiles, structural and other steels, building and roofing materials, cements, paints, inks, chronometers, thermometers, barometers, electrical apparatus of all sorts, radioactive preparations, and in fact anything and everything to which a mechanical, physical or chemical test can be applied. It tests the supplies purchased by the various departments of the United States Government. It has eliminated all fraud in this connection and has saved the country many millions of dollars. It is studying the telephone service, street railways, gas, electric light and power, etc. It furnishes manufacturers' chemists with standard samples of chemicals with which to compare their own product. It is investigating the magnetic properties of iron and steel. It is studying the properties of materials at low temperatures. It is engaged on the problem of standardizing radium. It is carrying on researches in connection with wireless telegraphy. It is conducting experiments on rubber in order to determine, if possible, the relation of its commercial properties to its chemical constitution. It is laying the foundations of an American ceramic industry by its study of native clays.

DESTRUCTION OF GERMAN GUNS BY OXY-HYDROGEN FLAME.

A periodical advertising bulletin, which the Draeger Company of Lubeck inserts in German technical publications, contains some interesting photographs showing the cutting-up and destruction of large-sized guns by the use of the oxy-hydrogen flame. One view, taken at Stettin, shows a very through destruction of gunzarrels, limbers and various artillery artillery mountings. Another photograph shows one of a number of 15, 24, 28 and 30 cm. guns being destroyed in the razed forts of Kiel, and it is stated that further eastwards 42 cm. guns in coast defences have been so rendered useless. One photograph shows a large howitzer with its barrel split from end to end by the flame.

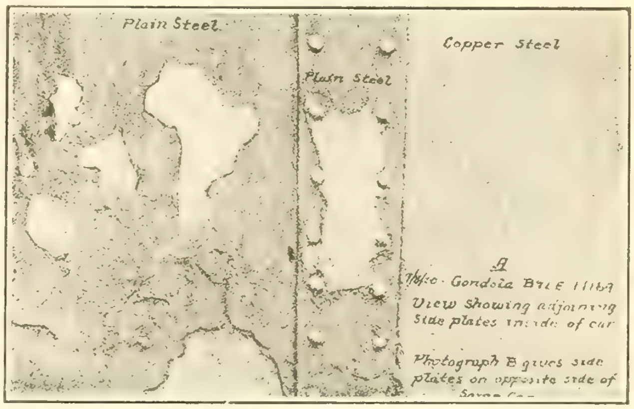
The Draeger Company, which made most of the gasmasks, oxygen breathing-apparatus, and appliances used for self-rescue in submarines, and for high flying in zeppelins and airplanes, during the war, has shown itself very adaptable to peace requirements. The use of photographs such as mentioned for purposes of advertising is an indication of the difficulty felt by other nations in comprehending the German psychology, either in victory or in defeat.

COPPER IN STEEL AND THE CORROSION OF CARS.

There has been controversy as to whether the presence of copper in small quantities in steel plates is a preventive of corrosion. To determine whether results would be obtained in the bodies of steel railroad cars and their life prolonged a railroad ordered 100 hoppers and 100 gondola cars using both copper bearing and plain steel plates in the same car body.

To make this test truly comparative, these cars were built so that the body of each car was made up of half copper bearing steel and half plain steel.

These cars went into service in 1914. The first cars inspected after two years' service showed that the paint on the outside of cars adhered much better on the copper bearing steel than on the plain steel. This fact has been borne out by all subsequent inspections, and at the end of six years is very noticeable, as will be seen by comparison of the illustrations showing the plain steel and the copper bearing steel plates in the same car. As a result of the absence of the protective coating, the plain steel shows considerably more and deeper pitting on the outside of the cars.



Showing comparative corrosion of plain steel and copper steel in the same car-body.

On the inside of the car, the copper bearing steel was freer from adhering ovide or rust and less deeply pitted than the plain steel. The accumulation of rust under the rivet heads showed that the loss in thickness was considerably greater on the plain steel than on the copper bearing steel.

On the outside of a car where the paint had come off recently, a pronounced difference was noted in the color of the exposed surface. The plain steel was rough to the hand, yellowish brown in color, while the copper bearing steel was much smoother and of a dark reddish-brown color.

The destruction of the body of a steel car is due to several causes, among which are mechanical abrasion or erosion and corrosion.

The character of the loads carried governs the destruction by mechanical abrasion, as there will not be as much abrasion with materials like ore, earth or cinders as with hard, heavy materials such as pig iron, steel blooms or billets. Mechanical abrasion also has an effect on the corrosion, tending to increase the corrosion by wearing away the corroded surface and exposing a fresh metallic surface, which rusts more rapidly than a surface protected by dirt and a film of oxide or rust. This explains why it was noted in the first inspections that the gondola cars were showing greater effect from erosion and corrosion than the hopper cars.

Canada's Coal Problem

(A Further Study).*

By F. W. GRAY.

At the Annual Meeting a year ago, the writer read a paper on "Canada's Coal Supply," and at the Winnipeg meeting in October followed up this paper by adducing the later statistics of production and supply then available, and emphasising the quite obvious importance of the Western coalfield to Canada, arising from the concentration of 99·3 per cent of our coal reserves west of the Souris lignite beds.

In the events of the year that has intervened there has been much to encourage those who urge that the problem of Canada's coal supply should be viewed first from the standpoint of national independence and defence, and that apparent commercial standards should be relegated to their proper position of lesser importance. The word "apparent" is designedly chosen. The cost of coal to Canada has for some time been largely determined by the purchasing power of our paper dollar, and this is, in its turn, largely set by the ratio between the coal we produce and the coal we import, so that, paradoxical as it may seem, apparent cheapness from the individual viewpoint may be the rankest prodigality from a national viewpoint.

The domestic production of coal during 1920 was the largest in our history and this is a matter for unreserved congratulation. As compared with 1919, we found 2½ million tons of coal, the equivalent of a $25,000,000 gold shipment to New York in support of national solvency.

Nevertheless the 1920 production was 5 million tons below the production capacity of the existing coal mines, a quantity that applied to domestic requirements would have been equivalent to a further gold shipment to New York of not less than $50,000,000, ignoring the stimulus to our internal economy that would have proceeded from the mining of this coal at home.

The output capacity of existing collieries is, however, by no means the capacity of domestic coalfields situated within proved economically-possible transportation distances of home markets.

The maximum possible production of the existing coal mines of Nova Scotia and New Brunswick has, for the purposes of the foregoing calculations, been placed at 8 million tons per annum, but there is no insuperable difficulty in raising this production—given time and expenditure — to 10 million tons. Such a production would make the Maritime Provinces and Newfoundland, Quebec as a whole, and a considerable area of Ontario completely independent of extranational sources of supply. In making this statement, it is of course contended that anthracite is not a necessary import in any Canadian territory within economically-possible transportation distance of domestic bituminous-coal mines.

The production of the Western coalfield is anything that Canadian opinion and support likes to make it. There is no limit fixed by the availability of coal, either in regard to quality or quantity.

The gap—the apparently unfillable gap, under existing conditions of transport facilities—is Ontario. Even Ontario could be made accessible to Nova Scotia coal by a deep water-way from the sea to the Great Lakes, and in all probability will so be made accessible by a succeeding generation.

For the present, therefore, Ontario must look to the United States for coal, and, in recent years, Ontario could not look elsewhere for coal seeing that even in those Canadian provinces plentifully supplied with coal, or situated within reach of the coalfields, the consumption exceeded the domestic production.

It is a proper thing that Ontario should import coal, because it is a necessary thing, but is is submitted that it is an improper thing from a national standpoint that the other provinces should import coal from extranational sources, because it is unnecessary.

Two recent newspaper despatches may be quoted as instancing typical viewpoints that are based on error and are subversive of national interests.

One despatch from Ottawa, dated 18th January, states "That the danger of a coal famine in Canada this winter, has been entirely removed, unless something should happen to interrupt importations of hard and soft coal from across the United States border, is the view expressed today by the Dominion authorities."

A second despatch, from Washington, quotes a U. S. Senator, speaking in a debate on a bill that proposes the raising of a higher tariff wall against Canadian goods in the United States, as remarking: "Canada, as she has always done, will continue to buy where she can buy cheapest, and if she can buy cheapest in the United States, she will continue to buy from us."

The impression given by the Ottawa despatch is that it reflects a resignation in official circles to continued dependence upon the United States for coal, and this can only be based upon an unfortunate disbelief in the possibility of independence.

The jibe of the U. S. Senator galls deep because it is true. That cheapness does not altogether consist in a relatively smaller outlay of money is not any less true.

These instances are quoted because they reflect a widespread opinion, that it is the duty of the Institute to inform and correct.

The foregoing review about sums up the existing situation, which the writer submits is unsatisfactory in the following particulars:

a. Coal output in Canada is disproportionately small in regard to the extent of the domestic coal reserves.

b. The domestic output has not kept pace with the population of the country, and the growing consumption of coal per capita.

c. That while some dependency on the United States for coal is inescapable, there is no good reason for the annually increasing dependency of recent years.

d. That there does not yet exist a unified public opinion in Canada that will demand the use of domestic mined coal to the maximum point of substitution for imported coal.

Before considering possible remedies, the following

* A paper presented at the Annual Meeting of the Canadian Institute of Mining and Metallurgy, Montreal, March, 1921.

facts regarding the relative coal resources of Canada are submitted, not as anything novel, but as bearing on the question at issue.

The coal beds of Canada, with a content estimated at $1\frac{1}{4}$ thousand billion tons, are about equal to those of the whole of Asia.

Canada has 17 percent of the world's coal reserves, and 71 per cent of the reserves of the British Empire.

With a consumption per capita that will ultimately exceed that of less northerly countries, Canada has a production of 2 tons per capita, Britain and the United States have a production of 6 tons per capita.

The coal consumption of Canada has always been restricted by insufficient supply, nor have the combined domestic production and imports in recent years met the requirements of the country. Manufacturing has been restricted, selling prices have been unnecessarily high, and the country has never been on "easy-street" in regard to coal supply. With present population, and potential manufacturing ability, Canada requires not less than 40 million tons annually. The historical maximum production of 16 million tons in 1920 is entirely inadequate. With a population of 10 millions, Canada should use 50 million tons of coal annually, if she is to achieve maximum manufacturing ability, freedom of political action, and domestic comfort.

In regard to the attitude of the United States towards our coal supply, it may be suggested that because of the exaggerated dependence of recent years that Canada has suffered through neglect to develop her own coal beds, we attach too great importance to what is, after all,(a matter of quite insignificant value to the United States. That country has an annual coal production which exceeds 600 million tons without having attained anything like the maximum possibility of production. The tonnage that the United States exports to Canada bulks small in that country's business, but to Canada it is a matter of economic life or death, and has probably the most important bearing on our continued political independence, being indeed our most pressing internal problem. We need not fear any criticism from informed opinion in the United States if this country develops its coal producing capacity to the utmost, but we do risk some justifiable and pitying criticism from the informed and well-disposed among our neighbors, and something worse from the ill-informed and hostile minority that is clamorous in inverse ratio to its numbers, if we continue to drop behind in the great international game of industrial emulation in which coal and iron are the king pieces.

What are the remedies and what of the future?

There are three territories to consider, namely:

a Eastern Canada, tributary to the Eastern Coalfield.

b. The "Gap of Ontario."

c. The Provinces West of Fort William. .

Two trade outlets are open for coal in the East, the home market (including Newfoundland), and the overseas export market. It does not seem an unreasonable aim that the Maritime Provinces and Quebec, including all the Railways that serve this territory, should be supplied with domestic-mined coal. The larger and more stable the market the more cheaply will it be possible to mine coal in Nova Scotia, and it may be permissible to contend that on no national grounds can the purchase of coal from extra national sources for national transportation lines be excused or defended without grave inconsistency.

The export trade, in view of the limited quantity of the coal reserves in Nova Scotia, is probably not one to be encouraged to a point of national deprivation, but it has never reached that point, and what promised to be the commencement of a permanent and profitable trade with Europe was quickly killed by the ill-advised export embargo of last summer.

Export trade is desirable at the favorably situated Nova Scotia mines and will probably develop later, and irrespective of conditions in Europe that are now passing and are losing some of their urgency. The record of the operators of Nova Scotia is sufficient to show that they have always paid first attention to the home market. No Nova Scotian coal has been offered for sale in the Montreal market since about 1916, but it will appear again in the summer of 1921.

In Europe, the nationalization of coal mines is a burning political question. Millions of men, including not few Canadians have fought and died for the coalfields of Europe. The coalfields of the Maritime Provinces is a lone and singular deposit in all Canada for a space of 1,800 miles. In this distance it provides the sole source of all the means of modern national defence that we have any right to call our own. It is producing, and has produced for six years, less than it did in 1913, yet the only definite action taken in regard to this incalculably precious national asset during this whole period has been the imposition of control and embargo.

The record is one that shows not indifference, because there is no necessity to apply such an epithet to men who have doubtless done their best to pilot the ship of state, but it does show, plainly that the primary national importance of coal supply has escaped the attention of our statesmen.

As to the "Gap of Ontario" there is little to be said except to urge the lessening of the gap by the maximum extension of the radius of distribution of the eastern and western coalfields, and to support any favorable engineering opinion on the feasibility of a deepening of the St. Lawrence waterway.

In regard to the Western Coalfield, in which is included the continuous deposits of Saskatchewan, Alberta and British Columbia, and the detached fields of Vancouver Island and Northern British Columbia, the conclusion cannot be avoided that here lies the future workshop of Canada.

In his classic work on the "British Coal Trade," Prof. H. Stanley Jevons, writing before the war, (in 1914) in regard to the untapped coalfields of the world stated:

"We have to recognize that the Malthusian check "to the increase of population operates in a totally dif- "ferent manner when people of any region change by "the aggregation of capital and spread of education "from a purely agricultural community to a manufac- "turing nation with an organized modern commerce. "A great stimulus to such a change will come "wherever coalfields exist; and the population will "thrive and develop upon the coalfields of the world, "almost like flies upon honey."

Edwin C. Eckel in an important recent book on "Coal, Iron and War" points out that under modern conditions, given the possession of raw materials, the

industrial growth of a community need not be slow, but may even be compressed into a period so short as ten years.

The application of these two mature opinions to the conditions in the Canadian West emphasise the obvious. Hitherto our dependence on extra-national sources of fuel has been associated very largely with the industrial eminence of Ontario, which is based on Pennsylvanian coal; but the new orientation which we see in the West promises an infinitely larger industrial growth over the western coal beds. Here, in the writer's opinion, will be founded the great pillars that will in the days to come support an industrial fabric transcending all present imaginings, and will, if wisely guided ,prove "the most stable guarantee of our political permanence as an independent people." The coalfields of the West are large anough to build a nation on.

The most hopeful sign in this connection is that the people of the West have realised their coming industrial importance, and those who were privileged to attend the Winnipeg meeting of the Institute realised that, whatever may be the case in the East, there has been formulated in the West that first requirement for a successful coal industry, what we will call a "coal conscience" among the general public.

It is evident however, that rapid as may be the growth of population in the West, the outlet for coal there is smaller than the existing capacity of the collieries unless an export trade is found possible. British Columbia is favorably situated, and its export trade is growing and is assured by the lack of good quality coal, except in Vancouver Island, along the whole length of the Pacific seaboard of North and South America.

The possibility of exporting Alberta coal to the States lying immediately south, and to outside points via Vancouver is not by any means a remote one, and the extent of this trade is limited only by the market available.

The writer suggests that the present lop-sided arrangement of coal interchange between ourselves and the United States may be restored to a point less endangering to national safety, and less humiliating to national pride, and at least to the fifty-fifty basis that formerly obtained, by the following procedure that is submitted as possible, namely,

(a) Complete independence of imported coal in the Maritime Provinces and Quebec, and in part of Ontario, achieved by enlargement of the Nova Scotian production.

(b) A moderate export trade from Nova Scotia to overseas points.

(c) Complete independence of imported coal in all Canada west of, say, Fort William or Fort Francis achieved by enlargement of transportation facilities, and recognition by the western railways that coal has become a permanent and growing feature of rail transportation in the West, both eastwards and westwards of the Alberta bituminous areas.

(d) Organized effort to secure export markets for Alberta coal, both southwards into the States and through the ports of Vancouver and Prince Rupert.

(e) Enlargement of the export market of Vancouver Island coal.

"THE ALGOMAN".

The "Algoman", the "Steel Men's Own Organ", issued by the staff of the Algoma Steel Corporation at Sault Ste. Marie is an increasingly interesting and useful publication and one that must be greatly enjoyed by its interested readers. Men and women alike — and the references in the "Algoman" to the "Algostel girls" are numerous and courteously gallant — are fond of a little gossip, and appreciate the spirit of comradeship that a publication like the "Algoman" can instill. The May number contains some encouraging figures and articles showing the good work that is being accomplished in reduction of work accidents, and in particular "Iron and Steel of Canada" notes an article by Mr. J. D. Jones, the General Manager. It is pleasing to see a busy operating executive able not only to record a reduction of seventy per cent in the amount of time lost through accident disability, but interested to the extent of writing the article for the plant-employees' magazine that appears elsewhere in this issue.

A character sketch of the President, Mr. W. C. Franz, and a life-sketch of Mr. James Hawson, the vice-President, are to be found in the May issue of the "Algoman". There is a very practical article on "Bloom Mill Practice" by Walter Harry, the Mill Foreman, and on "Safeguards for Emery Wheels" by Wm. Mann, Supt. Rail-Finishing Mill. Mr. Seymour, Superintendent of the Coke Oven plant contributes a note showing a creditably small percentage of accidents in the Algoma by-product coke oven plant when compared with the same class of work in the United States. Accidents in the by-product coke oven industry in the United States for the five year period 1915 to 1919 were seventy-six per cent greater than the experience of the Algoma by-product coke-oven department.

Mr. Frank McGue, the Superintendent of Industrial Service and Director of Safety, is the Editor, and is to be congratulated on his latest production. We appreciate Mr. McGue's opinion that getting out a magazine "is no picnic", but his labours must have been much assisted by the evidently very general willingness of all hands to give him practical help, both in "copy" and in achievements to be recorded.

OUR SAFETY CAMPAIGN A SUCCESS.

By J. D. JONES, General Manager, Algoma Steel Corporation.

(From the May-June "Algoman".)

Appended is a statement showing the accident situation month by month, from January, 1st, 1920, to May 1, 1921. It covers seven months of the campaign period and nine months of the pre-campaign period.

It may thus be regarded as fairly representative of conditions prevailing before the campaign and since the campaign went into effect. As we all know, our campaign has been mainly educational, utilizing, as we have done and are doing, the vehicle of publicity, in all its forms, to inculcate lessons of safety.

Does it show that we have been getting anywhere in our fight?

I think that it proves, conclusively, that we have. In the first place, as to frequency of accidents, on looking at the statement for the first nine months, one notices that the monthly totals hover around the 50 mark; as a matter of fact, the average for the first nine months was 53.5.

Comparative Monthly Statement of Accidents

From Jan. 1st, 1920, to May 1st, 1921

(Safety Campaign opened October, 1920.)

Month	Average No. of Men	No. of Accts.	Days Lost	No. of Accts. per day	No. of Accts per No. of men Empld.
January, '20	3265	63	1678	2.032	.0193
February	3279	43	993	1.483	.0131
March	3475	48	945	1.548	.0138
April	3388	56	1109	1.866	.0165
May	3166	50	1123	1.613	.0158
June	3090	45	1040	1.500	.0146
July	3012	53	1202	1.710	.0176
August	2993	63	996	2.032	.0210
September	3147	61	867	2.033	.0194
October	3106	42	605	1.358	.0135
November	2884	47	376	1.566	.0163
December	2146	29	319	0.935	.0135
January, '21	925	3	50	0.097	.0032
February	2324	15	153	0.536	.0065
March	1700	19	295	0.613	.0112
April	918	7	* 62	0.233	.0076

* Estimated disability.

Look at the figures for the succeeding seven months, that is to say, the months of the campaign, or from October, 1920. One notices an appreciable decrease in the total accidents **per month.**

Striking an average for these seven monthss, one finds that the rate is 23 per month — a reduction of considerably over 56 per cent.

Lost Time Decreased.

Look at the column showing time lost per month. We find that before the campaign, such monthly loss of time varied between 867 and 1678 days per month, or an average monthly loss of 1105 days, for the nine months immediately preceding the opening of the campaign — an extremely heavy loss for both men and the Corporation.

Look at the figures for the succeeding seven months. One finds that the monthly loss of time varies between 50 days and 605 days.

One must remember that the campaign opened only on the 15th of October, so that but little control could be exercised over the lost-time figures for that month, namely, 605. One, however, notices the gradual decrease in lost-time from October onwards.

And, this, despite the fact that for the period covered, there were two partial shut-downs, one at the end of January and one at the end of March.

Without casting reflections upon anybody, one must state a big salient fact in connection with these shut-downs.

This is, that, if a man were at all suffering from any injury prior to the shut-down and was away from work losing time and drawing compensation immediately prior to the shut-down, he naturally manifested a desire to be kept upon the sick list so as to be able to draw compensation during the shut-down, in so far as he could draw such compensation.

Hence the figures — 319 for December and 295 for March — are higher than they would have been had conditions been normal.

Even at that and even adding in those abnormal figures, what does one find?

A Notable Drop.

One finds that, whereas, for the nine months' period immediately preceding the campaign, the average monthly loss of time was 1105 days, in the campaign period, that is to say, from October, 1920, to May 1st, 1921, the average monthly loss of time was 265 days, or an average monthly reduction of over 70 per cent in the amount of lost-time.

But, it may be said, in the two periods the average number of men employed was not the same and thus the monthly accident totals would necessarily vary. This is true . But, even at that, an examination of the last column immediately demonstrates that the number of accidents per number of men employed, has also been considerably decreased.

One notices that, immediately the campaign had gotten well under way, that is, in the second month, the frequency rate showed an appreciable drop.

Thus, taking the amount of lost-time as a criterion of the severity of accidents, one sees an enormous decrease in severity — namely a decrease of 70 per cent — during the period covered by the campaign.

One notices that this severity would appear to be gradually decreasing, almost to a negligible point, month by month.

Alongside of the decrease in severity, one notices the decrease in frequency by number of men employed.

In looking at the second last column, one also notices an enormous decrease, also progressive and gradual from month to month, in the number of accidents per day throughout the plant.

In January, 1920, in August, 1920, and in September, 1920, we were running with an average of over two accidents a day.

Throughout the period of the campaign, we have been running with considerable less than an average of one accident a day.

And as stated above, the severity of accidents has been reduced over 70 per cent. Couple the decrease in number with the remarkable decrease in severity, and you realize what really great progress we have made.

So much for the figures contained in the statement.

Campaign's Lessons.

Looking at these figures in their true significance, as regards the men working in the plant, what is the lesson that they convey?

The great lesson is the considerable economic saving effected for the men themselves — in their general well being, their persons, their pockets and their efficiency.

Conservatively estimating the average daily wage earned by the men in the plant at $6, one finds that Steel Plant employees, during the pre-campaign period, suffered a loss of $59,718 in wages — that is to say — 9,953 days lost-time at $6 a day, or an average of 1105 days lost per month, making an average total of $6,630 lost in wages every month.

During the campaign period one finds that $6,630 monthly loss reduced to $1,590 — and the figures are still going down.

But, apart from this pecuniary loss to the man, is the general economic loss, both to the man and to the Corporation, resulting from the disorganization incident to many absences, replacement of absent men, training of new men to fill the gaps, general loss of efficiency, in fact, general chaos.

And this quite apart and distinct from the terrible moral loss resulting from accidents and the suffering endured both by the individual man who is injured, and by his family; the impairment of the individual's working ability and his efficiency; the maiming of men; in fact, no matter how one looks at the situation, one must be convinced of the fact that the Safety Campaign has been productive of well nigh incalculable good for everybody, for the man, for his family, for the general well-being and efficiency of the plant and for the Corporation.

Further Proof of Decrease.

Another interesting feature of the accident situation, is the classification as to nature of injuries received and the percentage of lost-time attributable to these various injuries.

Taking the campaign months — October, November, December, 1920, and January, February, March and April, 1921, as a basis and comparing them with the same seven months of 1919 and 1920 — that is to say, October, November, December, 1919, and January, February, March and April, 1920, one finds that in the last mentioned period, there were 316 accidents with 6,396 days of lost-time as a direct result of said accidents. For the same period of time covered by the campaign, that is to say, from October 1st, 1920, to May 1st, 1921, there were 155 accidents entailing a loss of time of 1,789 days.

In these figures, distributing the accidents as to their nature, one again finds evidence of the decrease in severity. For instance, there is a falling off in the number of fractures, the number of infections, and, especially in the number of miscellaneous injuries, notably foreign bodies in eyes. This is directly attributable to the educational work which we have been carrying on.

PRODUCTION AND USE OF NOVA SCOTIA COAL —WITH REGARD TO METALLURGICAL REQUIREMENTS.

By the Editor.

The highest output attained by the coal mines in Nova Scotia was 7,263,485 gross tons in 1913, which represented an output capacity of 7,500,000 tons, there having been a lack of demand in the late Summer and Autumn of that year.

The capacity of the mines for output in 1921, with uninterrupted work, and a full complement of face-workers, is about 6,500,000 tons, the difference of one million tons between the capacity of 1913 and this time being the result of exhaustion of some of the older mines within the eight years intervening, the suppression of capital expenditure by war conditions; and the deferring, from the same causes, of much of the usual advance development work underground.

The probable output, in 1921, under expected trade conditions, allowing for slack work in the Spring, and anticipating a brisk demand by Autumn, will probably reach 5,500,000 tons.

If it should prove possible to make heavy expenditures on new collieries during the near future, and if a sufficient number of face-workers could be made available, it should be possible, within a period of not less than five years from the commencement of a programme of intensive expansion of outputs, to restore the capacity of the coal mines to that of 1913, namely, 7,500,000 tons.

The maximum output that could be obtained from the Nova Scotian mines, with hope of maintenance for a period of years that would justify the initial expenditure, is estimated at 10,000,000 tons annually. It is unlikely that such an output could be obtained within less than ten years, and in seeking the attainment of a figure that means virtually doubling the present capacity of the Nova Scotia coal mines, it would probably develop that the chief difficulty would be to get a sufficient number of suitable workmen.

Before seeking to increase outputs to the maximum, operators would require to be satisfied if a market for ten million tons of coal annually were available.

A normal distribution of the present maximum production of 6,500,000 tons would — basing the distribution on pre-war business and the figures of 1920 — be about as follows:

	Tons
Used in Nova Scotia, including railways, colliery consumption, and metallurgical uses	3,300,000
New Brunswick and P. E. Island	900,000
St. Lawrence Ports	1,500,000
Newfoundland and St. Pierre	300,000
Local Bunkers	500,000
	6,500,000

Presuming that the steel industry were to work to full capacity, and not allowing for any increase in blast-furnace capacity or larger resulting coke-consumption over that of today under normal operation, the use of coal in the Province of Nova Scotia would reach 4,250,000 tons annually.

The consumption of New Brunswick and Prince Edward Island may be calculated, at a slight increase over the average of many years past, as being one million tons annually.

Newfoundland and St. Pierre de Miquelon will continue to require as much coal as in former years, and this may be put at 300,000 tons annually.

Bunkering has become an increasingly important part of the Nova Scotia coal-trade, and the coals of the Province proved their entire suitability for steamships' bunkers by wide use during the war. An annual outlet of 500,000 tons for this purpose is not over-stated.

The Boston market is not one that can be counted upon at this date, but it is also not one that can be definitely counted out. There are some possibilities in the future coal interchanges of Canada that may make the Boston market once more an important outlet for Nova Scotian coal.

The general export trade is also an uncertain factor, and until the nations of Europe settle down and international amity is more completely restored, it is not possible to say whether Europe will prove a market in which Nova Scotia can compete against the export coal of the United States. It should be remembered in this connection that Nova Scotia's coal reserve is a small one, and that there are a number of individual nations in Europe that have coal reserves which exceed those of Nova Scotia. An annual figure of 250,000 tons may be calculated as approximating the moderate export market that oversea demand will give to Nova Scotia coal mines.

The greatest and most potential outlet for Nova Scotia coal, and, from a national viewpoint, the most satisfactory and thoroughly logical, is that supplied

by the growing population along the St. Lawrence River and valley, along its whole length from the opening of the Gulf to a point that is yet to be determined, but is certainly not limited by the Port of Montreal.

The final report of the Fuel Controller estimated the annual coal requirements of the Province of Quebec at 3,900,000 tons of bituminous coal and 1,700,000 tons of anthracite. There is no doubt but that a proper use of bituminous coal would avoid the necessity of using anthracite for many of the purposes of domestic heating and cooking, but, ignoring this certain development of the future for the purpose of present calculations, it is safe to say that the province of Quebec requires 4,000,000 tons of bituminous coal annually, and it is also safe to say that it would be an extremely good thing for Canada if the whole of this quantity were supplied from the coal-seams of Nova Scotia.

Summarising the foregoing figures, the following table shows the potential market for Nova Scotia coal, which, it will be noted, is almost entirely confined to Canadian needs.

Nova Scotia	Tons	
Steel-Plant uses	1,550,000	
Colliery uses	750,000	
Domestic uses	750,000	
Railways	1,100,000	Tons
		4,150,000
New Brunswick and P. E. Island		1,000,000
St. Lawrence Valley (Prov. of Que. only)		4,000,000
Newfoundland		300,000
Ships' Bunkers		500,000
Foreign Export		250,000
		10,200,000

Comparison of this potential market with the estimated maximum output of the province of Nova Scotia will show that the supplying of Ontario (except in that triangle of the Ottawa and St. Lawrence which has more affiliations with Quebec than with Ontario as a whole) is not a matter of practical current politics. The Fuel Committee now sitting at Ottawa has directed some questioning to elucidation of the possible supplying of Ontario by Nova Scotia coal, but, so long as the province of Quebec is partially supplied with coal from the United States, and not wholly by coal from Nova Scotia, it will be unnecessary to devote attention to the supplying of Ontario with coal from Nova Scotia.

ENGINEERING EQUIPMENT COMPANY OF MONTREAL.

The Engineering Equipment Company, Limited, Sales Engineers, Montreal, have recently moved from 263 St. James Street to more commodious quarters in the New Birks Building, Phillips Square.

This firm is composed of men well known in the engineering industry and is specializing in mining, contracting and industrial machinery. They have bee fortunate in securing selling rights in Canada from some of the leading manufacturers of mining equipment in Great Britain and the United States. They are specially handling air-compressors, rock-drills, pneumatic tools, hoists and pumps.

The officials of the Company include:

Norman M. Campbell, Managing Director of the General Combustion Company, Limited, and for many years General Sales Manager of the Canadian Ingersoll-Rand Company. Mr. Campbell is well known to both the Mining and Industrial Community.

Mr. Samuel Seaver, formerly Canadian Sales Manager for Sullivan Machinery Company and Canadian Rock Drill Co., equally well known to the Canadian Mining Industry.

Mr. F. H. McKechnie, formerly associated with McKechnie and McLaren, Sales Engineers, Montreal.

Mr. Percival J. Woolf, late Manager of the Duluth, Minn., office of the General Electric Company and for some time associated with the Chicago Pneumatic Tool Company.

The Company has recently opened a Pacific Coast Office at 609 Credit Foncier Building, Vancouver, B.C., in charge of Mr. J. N. Bell, for many years in charge of Canadian Ingersoll-Rand Company's work on the Coast. They have also concluded arrangements for the opening of a branch office in Winnipeg to handle the middle-West territory.

CANADIAN JOHNS-MANVILLE CO. TO MANUFACTURE ASBESTOS PRODUCTS IN QUEBEC.

The Canadian Johns-Manville Co., Ltd., with sales offices at Montreal, Toronto, Winnipeg and Vancouver —which for some years has been operating one of the largest asbestos properties in the world, located at Asbestos, P.Q., has placed contracts for a large manufacturing plant to be located at Asbestos, P.Q., where they will manufacture all classes of asbestos products formerly imported from the United States. These products include asbestos paper, asbestos roofings, asbestos shingles, packings, pipe coverings, asbestos textiles, brake band lining, etc.

IRON & STEEL

OF CANADA

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F. W. GRAY, M.I.Min.E., Editor.

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CONFLICT OF ECONOMICS AND NATIONALISM IN OUR STEEL INDUSTRY.

The article by Mr. J. F. K. Brown in this issue diagnoses some of the difficulties and contradictions that exist in connection with the steel industry in Canada. Our contributor points out that central Canada is a natural extension of the central competitive area of North America, and that the steel industry must therefore, in this district, at all times exist under severe competitive conditions. The coast regions, on the contrary, are outliers on competitive areas surrounding the Atlantic and Pacific oceans respectively, and should, naturally, look for export markets. From these considerations, Mr. Brown concludes that the Canadian viewpoint of the steel trade should be first international and "only secondly national".

The presentation of the status of the iron and steel industry in Canada and its attractiveness or otherwise to capital, as put forward by our contributor, is novel, and a little upsetting, because of its having been conceived from a consideration of economic and geographical factors, uncomplicated by interjection of national political boundaries and considerations. The international boundary, the entirely different political and competitive considerations of our Atlantic and Pacific coasts, and the protection of Canadian nationalism, are however matters which must be taken into first account, and forbid any purely economic reasoning unless it is accompanied, and admittedly complicated, by some conditions of a national character that, while they occasionally serve to enliven our politics, are nevertheless the traditional and accepted basis of Canadian policy.

There is little use in blinking the fact that but for protective tariffs the iron and steel industry in Canada would not have been commenced, nor would it have grown to present dimensions. The industry in the United States is founded on possession of the requisite natural resources, but even in that uniquely opulent country, it has been considered necessary to protect the industry against European competition. Tariff protection against imports of iron and steel, or anything that is made by the aid of coal, is less needed by the United States than any country, but nevertheless it has been thought necessary. In Canada, the steel industry does not entirely rest on possession of the requisite natural resources; but, for national reasons, this country has desired, and will still, we believe, desire to have steel plants. By the granting of bounties, and the protection of import duties, that steel industry was founded, and has since existed.

It is true that there is a point beyond which it is fatal to pit national considerations against unadulterated economics, and Mr. Brown's careful analysis of the fundamental essentials for financial success in steel manufacture, is a welcome corrective of much that has been written and said about the steel industry in Canada by persons whose enthusiasm exceeded their knowledge of its very definite limitations. Nevertheless, it is equally certain that our statesmen cannot, unless they reverse the policy which has made Canada, undertake to view some features of the industry solely from the economic viewpoint. The considerations of national defence and self-sufficiency should precede and modify all government action bearing upon the status of the iron and steel trades in Canada.

BUSINESS PROSPECTS.

A New Glasgow contributor in this issue suggests active co-operation of industrial leaders and labour organizations in the restoration of business confidence and in bringing about that and the reduction of selling prices which it is generally assumed is necessary to awaken purchasing demand. So far as the iron trades in Canada are concerned it is not possible to initiate policies of this character, because we are so largely included in the sphere of influence of the United States, and must, to a degree that is at times not at all pleasant await the reflex of financial movements in that country. The announcements of the Bethlehem Steel Company and of the United States Steel Corporation with regard to reductions in the selling prices of steel, the widespread and daily reports of substantial wage reductions and rapid fall of commodity prices, indicate that the United States is rapidly putting its house in order.

Loanable funds are accumulating in the banks, stocks of copper, steel, petroleum and miscellaneous metals have been drastically reduced by cessation of production, commodity prices have been reduced to such an extent that wholesale stocks in large part used up will have to be replaced at higher costs than immediate quotations. The stock market has surely discounted all that the most avid pessimist could desire to happen. Europe is coming back socially and financially, and the communist idea is no longer fashionable. The business barometer of the United States, while it has not reached "Set Fair" is gradually rising, and industrial leaders seem to be actuated by a sense of responsibility.

The outlook for Canada would seem to be for a

return to better business conditions at a date which will be a little later in time than revival in the United States, as the depression was a little later in reaching Canada at its onset. Possibly the Winter of 1921-1922 will be the time when industrial slackness will be most pronounced in Canada, and it will be a matter for serious consideration by industrial executives to decide how far they may dare to use their financial resources to hold working organizations together pending a possible revival of demand and purchasing ability in the Spring of 1922. So far, particularly in the iron trades and in coal-mining, there has been a disinclination among labour leaders to face the absolute inevitability of very substantial reductions in labour costs entering into production. This may be brought about by heavy wage reductions applied to present numbers of workers while maintaining existing hours of labour; or the individual effect can be minimised by elimination of unnecessary workmen and an increase in working hours of those who are retained. It is not to be expected that industrial executives can dissipate slim financial reserve to maintain employment on a basis that is economic and out of joint with the changed times, and conferences between employers and employees require to be immediately arranged, not to deal with theories of employment and remuneration, but to devise, if it be possible, how to make a short loaf go round.

TARIFFS ON "WAR MINERALS".

There is a noteworthy reaction in the United States against over-extension of the policy of protective duties and against the wholesale imposition of tariffs upon importations of that class of minerals which have come to be classed as "war minerals". Articles which have appeared in such representative technical papers as "Iron Age", "Engineering & Mining Journal" and "Chemical and Metallurgical Engineering" attack tariff proposals designed to aid domestic producers of such minerals to continue profitably a production which was stimulated by the war, and, in some cases, practically demanded by the authorities. This tendency was to be expected, because of the nature of the resources of the United States. In the most important respects for maintenance of a modern industrial structure, the United States is better situated than any other nation. In coal, iron, petroleum, copper, zinc, fluxes and salt, the United States is opulent, but there are a number of minerals, not large in regard to tonnages required, but important in regard to necessity and in point of quality, that the United States does not possess in sufficient supply, or which can be obtained in better grade and at cheaper rates by importation from outside. There are some minerals which the United States must have which, as one writer puts it "under no imaginable circumstances" could be supplied from domestic resources. Some of the minerals used in the iron and steel industries that, before the War, were imported into the United States, are chrome ore, pyrites, magnesite, graphite, tungsten, vanadium, molybdenum, cobalt and nickel. It is argued that while the imposition of heavy import tariffs on these minerals is necessary to maintain the production of such of them as are found in the United States, it is not for the good of the country at large that the production of the heavy tonnage industries should be penalised to maintain what after all is an uneconomic development resulting from war conditions. It is also argued that the United States should conserve, against a day of possible future need, such limited reserves of war minerals as it may possess, and should resume its former practice of importations, while guarding against too great dependence on outside sources for some essential materials.

The matter is one that vitally interests Canada, as in this country, so far as the steel industry is concerned, the conditions are reversed. Canada possesses a limited quantity of some essential minerals, particularly asbestos, nickel, cobalt, mica, chrome magnesite and graphite, but she does not possess the sufficient supplies of iron and coal that are found in the United States.

F. Lynwood Garrison, in "Iron Age" concludes an article on this general subject by stating the general broad principle that what is best for the whole country should be the law, but remarks: "What that best should "be is likely to be difficult to determine, and can be "justly decided only by those familiar with the whole "country, its natural resources as well as local indus- "trial and social conditions. Obviously, such com- "plicated problems are difficult to solve by a legisla- "tive body as large as Congress, subjected as it must "ever be to all sorts of cross-currents, conflicting in- "terests and local political influence and prejudices. If "high standards of comfort and living are to be main- "tained in this country a protective tariff is absolutely "necessary. The point is to have it applied with the "greatest wisdom and skill, *and that can only be done by experts devoting their whole time to the subject*".

The italics are ours, but Mr. Garrison's conclusion is just as applicable to Canadian conditions as to those across the border. The committee of the Canadian Cabinet which recently made an enquiry into this country's tariff requirements would probably, in their hearts, sincerely endorse the statement quoted. It is one of the humours of modern legislative tendencies to assume that tariff formulation requires no equipment but preconceived opinions, when actually it is a most complicated branch of political economy; and to be advantageously undertaken, requires expert knowledge, ample time for study, and the highest intellectual qualifications.

SIR ROBERT HADFIELD, FRITZ MEDALLIST

The award of the Fritz Medal to Sir Robert Hadfield, and the taking of this coveted honour to London by a deputation of American engineers for presentation at a meeting of the Institution of Civil Engineers at the end of June, is an international courtesy which

will please Canadian iron and steel metallurgists, particularly that not inconsiderable number who claim Sheffield as their school. The record of Sir Robert Hadfield is well known to this side, but the condensed record of these and the tribute paid by a recent number of "Chemical & Metallurgical Engineering" is so gracefully worded as to merit wide reproduction in British trade papers, which should not miss mention of an incident that is in every way happily conceived and of most excellent omen.

Sir Robert Hadfield's firm has not only excelled in technical achievements, but its world-wide sales are partly attributable to business enterprise of a rather unusual type in Sheffield. Messrs. Hadfield & Sons have always quoted their goods in the currency of the country they desired to do business in, and their trade literature and catalogues have been printed in foreign languages. The growth of Hadfield's Tinsley Plant near Sheffield was a marvellous thing even before the great stimulus of the war, but during the war-period it was probably unexcelled by any of the wonderful developments that took place in Britain. It is good to see representative engineers from the United States combining to honour a man who in addition to great achievements in metallurgy, has also been a doughty commercial competitor, and has contributed as much as any living man to the growth of the iron and steel industry in Britain.

REVIEW OF THE BRITISH COAL STRIKE.

So far as the terms of settlement of the British coal strike are concerned they are very indeterminate, and involve such new principles in British industrialism as to justify Premier Lloyd George's description of the compromise as "a great and promising experiment". The magnitude of the experiment will be admitted, but its promising character is something only the future may demonstrate.

The failure of the miners' leaders to attain their aims will however, have a very decisive effect, and one that will by no means be confined to Britain. The miners' leaders accepted the task outlined by the international miners' congress at Geneva last year, which was to lead a frontal attack upon society as now organised. The international delegates to this congress, realising the essential necessity of coal supply, decided they would lead the vanguard of Communism and adopted the policy of "nationalization" of coal production as the first and easiest step in the abolition of private property. The British miner, whose loyalty to his leaders and capacity for patient endurance is proverbial and has been well illustrated by the recent strike, has been made the "goat" of Europe, and no trades-union leaders have so misused their power and so misdirected the energies of their followers as the executive of the Miners' Federation has done. The miners without doubt expected co-operation and financial aid from the European and American miners' unions that were represented at the Geneva Congress, and they also looked for sympathetic strikes of other trades unions in Britain itself, and in every instance they were disappointed.

It was made clear in the Autumn of 1920 that when the crisis of March 31st arrived the issue would be a political one, and that "nationalization", which is another name for abolition of private ownership, would be put before questions of hours and wages. The miners' leaders were so ill-advised as to make a main issue of another purely political question, namely, that of the national wage pool. This proposal not only involved confiscation of private profits but prescribed the method by which they should be distributed amongst the workers. As the miners' leaders made the granting of both these political demands preliminary to any discussion of wages or any return to work, the public immediately saw the vital nature of the issue, and, from the commencement of the strike to its close, British public opinion was definitely unsympathetic to the course taken by the miners' leaders, while at the same time not unsympathetic to the miners' cause as a whole.

The miners themselves became dissatisfied with the nebulous nature of the things they were supposed to be fighting for, and at the time of the ballot which shortly preceded the settlement of the strike, they took but a listless interest in the vote, because their leaders had abstained from advising them in any way as to how they should vote. The attitude of the men expressed a general feeling among them that the leaders having got them into a mess should get them out of it.

The attitude of the other trades-unions in Britain was based on the common knowledge that coal prices were so high as to cripple all the customary forms of British industry, and as to make operation of steel plants, railways and shipbuilding yards an impossibility. The other unions saw clearly that the preferential treatment in wages and hours demanded by the coal workers was taking the bread from other workers, and there exists, moreover, an understandable jealousy among British workers of the glaringly partial and preferential treatment accorded to the coal-miner.

The major significance of the defeat of the aims of the miners' leaders is that it expresses public disapproval of the action of a section of workers in demanding exceptionally favourable terms, and justifying a demand for such terms, not by inherent right, but by ability to force granting of these terms.

The success of the British Cabinet in upholding the general public good against a selfish sectional demand should not however disguise the fact that the miners have obtained much of what they asked, and have so far succeeded in establishing enforcement of the theory "All Wealth belongs to the producer" that they will in future take 83 percent of all profits above the standard percentage allowed to the coal operators. Also, since the Sankey Commission, legislation has passed which will "nationalize" all coal deposits in Britain to the extent that they will become the property of the State, upon payment of their assessed value. The fact that so-called "surplus profits" in coal-mining are unlikely to

be made until coal-production costs in Britain can be brought down to a competitive level, does not at all detract from the acceptance by British coal-owners of a principal that limits their profits and turns any surplus over to the workers.

Further, the British Government has agreed to augment the miners' wages by a subsidy, which sets a precedent in regard to other large industries still to undergo de-control that may well perturb the British taxpayer, unless that patient person has passed beyond the possibility of pertubation.

And when all is said and done in connection with the British coal-trade, all concerned, workmen, owners and government, have yet to realise that Britain's competitive ability, based on moderately-priced coal, has largely passed away, and that by no financial magic or decisions of national wage boards will it be possible to extract a revenue from the industry if coal costs more to mine than its selling price, or the aggregate selling value of the articles it is used to manufacture — a condition that now obtains in Britain.

The terms of settlement are neither as definite, or as lasting in their effect, as could be desired, seeing that the agreement is terminable upon thirty days notice, but they are probably as permanent as the temporary character of many industrial and trade conditions justify attempting.

AMONG the birthday honours announced on June 3rd there is a fair percentage of men selected for titles because of distinction in the technical arts.

Among the baronets is Douglas Alexander, head of the Singer Manufacturing Company "one of the first firms to make six inch and fifteen inch shells entirely by women labour."

Joseph William Isherwood, inventor of the Isherwood system of longitudinal construction of ships, and a member of the Institute of Naval Architects, is another baronet.

Llewellyn Southworth Lloyd, assistant secretary to the Department of Scientific and Industrial Research since its formation, is made a C. B.

Among the knights is William Henry Butlin, for twenty-four years chairman and managing director of an old family business of iron-smelters at Wellingborough. "He has devoted his life towards improving the quality of British pig-iron."

Other men honoured by knighthoods include famous physicians, builders, mining engineers, ordnance experts, etc.

Mr. Butlin's record of having "devoted his life towards improving the quality of British pig-iron" is almost quaintly expressed, and in a manner that may shock that rapidly diminishing class who despise the wedding of science and good business. It is nevertheless a good record, and one of which any man might be proud. In Canada, unfortunately, a man might build a world-famous bridge, invent a metallic alloy, a gun, a new antiseptic, develop a rust and frost-resistant wheat, throw light on the theory of the atom, discover and name a new element, and many other things that Canadian workers have done, but there is no means by which he can be nationally honoured. Parliament has, unthinkingly, destroyed Canadian access to the only central fount of honour in the British Empire, and it has not yet instituted a substitute. A resolution passed by a technical society, or the granting of an historic medal or a university degree, are things that are probably more appreciated by discerning recipients than titular honours, but they are not understood of the people, they do not mark their recipients out as men of national repute, nor do they call for a citation in which the life-work of the recipient can be summed up for all the world to read. Great wealth, newspaper notoriety, and other accompaniments or causes of fame in these days, are the last things desired by the men who deserve the best of their country, but their possession is the mark by which the public measures its great men today, and, until Parliament devises some means of conferring distinction upon eminent Canadians, there is really no other measure that the general public can use.

IRON AND STEEL IN SWEDEN.

The Swedish Chamber of Commerce of New York has forwarded an account of the iron and steel industry of Sweden and a directory of firms connected therewith which is compiled and published by the A. B. Svenskva Teknologfoereningens Foerlag in co-operation of the Jernkontoret, or Iron Masters' Association of Sweden. The information contained as to character of products, description and names of firms and locations of works, is official and correct. The preface states that if an industry in any country "with some right may be considered a natural consequence of natural resources and historical development this is certainly the case with the iron and steel industry in Sweden". The book, which extends to almost 200 pages, is very fully illustrated and contains a well-arranged mass of information, much of which is of interest to Canadian readers, in view of the similarity between some conditions in Canada and Sweden, such as northern location, plentitude of water-powers, and special character of iron ores combined with regional lack of coal deposits. The address of the Swedish Chamber of Commerce is Produce Exchange Annex, New York.

LAUNCH AT HALIFAX SHIPYARDS.

The S. S. "Canadian Cruiser", 10,500 tons d.w. was successfully launched at the Halifax Shipyards on July 9th. The naming ceremony was performed by Mrs. G. H. Murray, wife of Premier Murray, and water from the Pacific sent by the Mayor of Vancouver was used. The "Cruiser", which is the largest vessel built in Canada for ocean-going purposes, is 445 ft. long, 56 ft. beam, 38 ft. depth and has a draft of 29 ft. A second vessel, of similar dimensions, will be launched in the Autumn.

The Present Status and Future Possibilities of the Iron and Steel Industry in Canada

A Review of the Fundamental Conditions of Existence and Growth of Iron and Steel Manufacture, of the extent to which they are present in Canada, and a Discussion of the Advisability of Capital Investment in Iron and Steel Enterprises in Canada.

By J. F. K. BROWN. *

Introduction.

In treating of the present status and future possibilities of the iron and steel industry in Canada in these pages, the writer was influenced by the following motives:—

1. The seeming need of a summary of the subject in its relationship to the Dominion as a whole and the position of the Dominion in this industry in the world, in order that its possible growth may be more clearly visualized against the conditions in other lands, and what has been and is being accomplished elsewhere.

2. The necessity of aligning known raw material and natural resource conditions with the commercial facts that ought to be understood and taken into consideration whenever a discussion of the question arises, in contra-distinction to the frequent irresponsible expressions of Canadian possibilities that more frequently than not obtain wide publicity.

3. The need for crystallizing and defining some fundamental conditions requisite to the growth of the industry in order that a proper line of action and direct points of attack may be outlined along national lines, reaching towards future development.

4. Increased protection of Canada's established reputation in the industrial financial markets of the world.

The first three postulations will be readily understood, but the fourth, which is the main reeason for the following pages, is so important that it deserves some additional explanation.

The development of any growing country is dependent upon two equally important and vital facts:—

(a) A steady tide of the right kind of immigration.

(b) A steady influx of the right kind of capital.

Of (a), Canada has made a considerable success, but of (b), she has been as negligent as all her competitors, and yet it is just as possible to scientifically introduce and maintain the needed stream of capital as it is to scientifically select and bring out the better class of immigrant. Results in both cases are subject to, first an analysis of what is wanted, second, a publicity campaign advertising these facts, and third a measure of control over the returns of that campaign.

In the division of immigration, a simple analysis of the country's needs showed that the great requisite was agricultural expansion, publicity was almost exclusively shaped to that end, and finally control was exercised on the class of immigrant accepted. In the division of capital, it still remains to educate the country to the fact that a commercial analysis of its needs will reveal where capital can be most advantageously utilized as to both time and class of expenditure; publicity along these lines can and will advertise those needs when correctly appreciated, and a measure of control will sooner or later be introduced when it is finally realized what a terrific economic loss results from a misapplication of capital to industrial ventures large and small.

The reputation of a country in all financial centers is based upon the good faith of the projects proposed for investment of capital. The increased flow of the capital so necessary to the growth of a developing country, depends on the good faith remaining spotless. Therefore, every project brought forward intentionally or unintentionally which is based on basically wrongly-conceived natural-resource facts, industrial or commercial principles, tends to promote suspicion of that good faith, until finally a loss of reputation results in capital grasping the many opportunities always available elsewhere.

Enquiry into the actual disposition of capital available for investment over a given period would disclose that the ultimate useful amount which reaches Canada is pitiably small in comparison to the amount that might ultimately be invested to her advantage. Calculations have been made to show that $200,000,000 of capital goes to Canada from America every year, while the Federal Banks estimate that $500,000,000 is lost annually in the United States, or 2.5 times the amount that goes to Canada.

Could it be possible to devise some means of

1st. Eliminating the percentage of unsound projects.

2nd. Raising the percentage flowing to Canada, or

3rd. Decreasing the waste after commencement;

Canada's opportunity in any period to obtain financial assistance from the sum total of development capital available would be immeasurably increased, and her growth unquestionably very appreciably advanced.

There are two ways of accomplishing this: the first of these is through the enactment of so-called blue sky laws, and the other is through the dissemination of the fundamental natural and commercial facts underlying the conditions of an industry, and not merely a technical statement of its raw material resources. It is more important for example, for capital to know and realize that the Alberta coalfields were in past years developed beyond the market consumption than it is to be enthused over the statement that Alberta contains 13 per cent of the world's reserve of coal. In other words, education on proper lines of a country's possible future development is what is required, and it is in an ambitious endeavor to present the subject largely from this point of view that these lines are written.

The subject under discussion covers two main divisions:—

Part 1.—The major features concerned with the establishment of iron and steel plants, the raw material re-

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sources available and the conditions thereof and

Part II. The commercial possibilities of secondary and smaller industries based not only on primary products made in Canada, but also on semi-finished products, both native and foreign.

In both cases the desire is to indicate as far as possible where the possibilities for the investment of further capital in this industry can be said to exist within reasonable limits subject to further intensive commercial study and to point out either the limits of expansion or indicate standards which must be adhered to attain commercial success under conditions as they appear in Canada.

Raw Material Resources.

There are in this industry two main raw materials required:

(a) Iron ore.
(b) Coal.

A. Iron Ores.

It has been stated that the steel industry of the Dominion is exotic in that it does not exist upon native-mined ores. In a survey of the world's iron and steel trade, this is true of every great steel-making country to a greater or lesser extent. In America, for certain economic production reasons, a proportion of ore is imported from Cuba and much more will be imported from that country and from Chile; the ores of Spain have been for years a great help to the British steel industry; of recent years the ores of Scandinavia have performed a similar service to Germany, while the development of the North African ores have helped three countries — France, England and Germany. It, therefore, seems that under modern conditions, it is the exception, rather than the rule to manufacture steel entirely from native ores, and further in the future growth of the steel business this situation will increase as the world is searched more widely for high-grade merchantable material.

The following table shows that in only three countries out of those usually looked upon as steel-producing countries does the domestic production of ore exceed home consumption:

Normal Consumption of Iron Ore by Chief Making Steel Countries.

	Consumption in Long Tons.	Production in Long Tons.
United States	62,000,000	75,288,851
Germany	40,00,0004	33,987,112
Great Britain	19,000,000	15,997,328
France	12,300,000	21,572,746
Russia	8,900,000	9,362,746
Belgium	6,800,000	164,734
Austria Hungary	5,200,000	5,233,053
Spain	1,000,000	9,705,963
Sweden	700,000	6,878,318
Cuba	.....	1,585,431
Newfoundland	.....	1,433,858
North Africa	.....	1,349,000

Great Britain's imports (see following table) are typical of this tendency, and show long travel of ore from European and North African points to Britain. Similar conditions could be instanced both of existing and possible ore-transportation routes, and the practice is one that is likely to increase. Two routes, suppositious as yet, that may be mentioned are the Asiatic Coast to British Columbia, and Wabana, Newfoundland, to Montreal.

Iron Ore Imported Into Great Britain

	1910*	1920*
Spain	3,134,108	3,144,147
Sweden	143,917	366,943
Norway	48,200	132,987
Algeria	581,391	778,650
Greece	20,417	39,420
Tunis	237,795	252,894
Other Countries	265,633	406,046

* Ten Months Imports.

A study of the geographical situation of the raw materials of the iron and steel trade of the world will confirm the foregoing, and will bring out some features that are of significant interest to the trade in Canada. These features specially attaching to Canada are:

(a) The absence of complete economic independence in any state in its steel making requirements.
(b) The distances steel making minerals are transported.
(c) The three main competitive market and production regions.

(*a*) Everywhere throughout the world there are deposits of certain minerals that by reason of their situation, quality or cost of operation, control or dominate their particular market. These deposits are well distributed and cannot be said to be monopolized by any one state — they represent one of the few outstanding natural assets each land is endowed with. This applies, not only to ore and coal, but to the considerable number of lesser minerals that while not absolutely essential in one way to the steel making process, are from the point of view of the character and class of product as important as the ore itself. Thus the situation presented is somewhat as follows:

Mineral	*Dominated by*
Manganese	Brazil, India, South Russia.
Chrome	Rhodesia and New Calendonia.
Nickel	Canada, New Calendonia.
Tungsten	America, Burma.
Vanadium	Peru.
Molybdenum	America, Canada, Australia.

(*b*) This has already been mentioned.

(*c*) It is at once evident that under modern conditions of long ocean freight hauls at competitive figures general equality of production on the basis of cost of extraction, concentration and quality of ore being approximately in balance, that there are at present three main competitive areas.

1. The Atlantic Ocean area, which would include on the American side, Newfoundland, eastern coast of Canada, America and Brazil down to the Argentine, and on the European side from Scandinavia in the Arctic Circle down to South Africa. In just just so far as there is not internal production in any lands swept by the Atlantic, an export-trade production by a country bordering on the pool can penetrate into the interior markets of others. Thus, although there is a smaller competitive iron-ore area growing up in South Africa, it is not yet sufficiently outlined and defined to keep out the products of other concerns operating on the edge of the main pool. The same remarks are applicable to a subsidiary pool in India.

2. The interior area of America, centered in Pittsburg for manufacture, and Lake Superior for ore.

The edge of this area is moving both eastward to the coast where it overlaps and competes with the western edge of the Atlantic area, and westward to the Pacific coast. This competitve region is of interest to Canada since within it is contained the largest iron and steel production center in the Dominion and within it in turn are two possible secondary competitive areas that have future possibilities.

3. The Pacific Ocean area is at present largely undeveloped, both as to raw materials, production points and markets. Mainly its needs are unknown, and where they are known, are supplied by overflow from the Atlantic Ocean area. Five countries have potential competitive outlooks: — China, Japan, Australa, America and Canada, each have windows on this area.

First.—Under modern conditions of steel making, the territory in which ores can be sought for to feed steel-plants is world wide, and this is the more true the nearer the plant gets to a coast line.

Second.—That absolute control of raw-material resources within the boundaries of the country in which the plant is built is a thing that does not exist, and consequently steel plants of the first magnitude must think internationally rather than nationally — they are interested in steel-making mineral development thoughout the world.

Third. — That by reason of the fact that Canada possesses suitable coal fields on either coast, and is dominated in her central areas by the competitive production of another country, her viewpoint of the steel industry should be first international, and secondly national.

Fourth.—Central Canada being a natural extension of the central competitive area of the American continent, steel industrial expansion there must at all times exist under severe competitive conditions.

Magnitude of Ore Deposits.

Only ore-deposits of first magnitude will support a steel industry. In a way this is apparent from world traffic in iron-ore that has been previously emphasised, inasmuch as there would never have been so wide a trade if it has been commercially possible to support the industry upon iron-ore deposits small in extent and low in quantity which each of the steel-making countries possesses in considerable abundance.

A commercially minable iron-ore deposit must meet three conditions:

1. It must possess vast reserve capacity.
2. It must produce steadily, and,
3. Its production must be consistent in quality.

Attention has been drawn to three main competitive areas. It is interesting to look over the status of the principal ore-bodies catering to the steel interests in these regions. They are as follows:

Competitive Area.	District.	Tons.	Average Percent Iron Content	
Atlantic....	Brazil	5,000,000,000	68	Minaes Geracs District.
"	Newfoundland. .	3,500,000,000	40	Wabana Deposit only.
Central	Lake Superior. .	2,750,000,000	51	Gogebic, Vermilion Mesabi & Cuyuna Ranges. No concentratable ore inc.
Atlantic....	Sweden	2,200,000,000	57	Mostly in deposits requiring concentration largely magnetites.
"	Nor. Cuba	3,300,000,000	26	A proportion in deposits requiring some form of beneficiation.
"	N. Y.-N. J. . . .	2,500,000,000	35	Mostly magnetites magnetically concentrated.
Central	Alabama. . . .	1,750,000,000	36	Easily mined ore close to coal fields.
Atlantic....	Norway	500,000,000	35	Mostly magnetic concentration propositions.
"	Great Britain . .	318,000,000	30	Majority low-grade ores requiring considerable beneficiation.
"	France..	3,300,000,000	38	Briery Meuse-Moselle ore fields, others in Normandy.
"	Spain..	700,000,000	55	Many areas still dormant.
"	North Africa . .	150,000,000	48	Exploration difficult beyond coast line.
Pacific.....	Chile...	100,000,000	60	Toto deposits only. Other areas.
Atlantic....	Greece.... . . .	100,000,000	53	Copper and other metals present. Small quantities.
Pacific.....	Australia. . . .	113,000,000	52	Many deposits known but not estimated.
"	China.. . . . .*	400,000,000	50	Much less than supposed and scattered.
"	Mexico..	360,000,000	60	Durango deposits only. Other areas.

* H. Foster Bain, A. C. Spencer, C. M. Weld, Waldemar Lindgren, E. C. Harder.—Notes on certain iron ore resources of the world. Trans. Amer. Institute of Mining Engineer.—E. C. Eckel, "Iron Ores" 1914. Iron Ores of United Kingdom 1917.

In the above list there is included the majority of the primary ore-deposits of the world, and it is interesting to note the aggregation of reserves north of the Equator, and also tributary to the Atlantic area, namely:

	Tons.
Atlantic	27,568,000,000
Central	4,500,000,000
Pacific	973,000,000

showing the vast predominance of the ore reserves existant in this area. It has to be remembered, however, that the Pacific area is not so well explored and will probably exhibit greater reserve capacity than that indicated.

The unit cost at the furnace provides an interesting standard to which fresh developments must conform to be competitive. Despite their variety of location, difference in ore content and cost of mining, they are competitive on a surprisingly small variation of cost per unit at the furnace in two iron and steel areas—Atlantic and Central:

	[illegible] Iron Content	[illegible] Mining	[illegible]	Freights to Atlantic Valley	Cost to Furnace Per Unit	[illegible]
Brazil. . . .	68	$1.00	$4.00	$5.60	$.074	$.097
Newfoundland.	40	1.25	1.25	2.85	.062	.102
Lake Superior	51	3.15	2.80	1.70	.117	.095
Sweden . . .	57	2.00	2.00	3.60	.070	.098
Nor. Cuba . .	26	2.00	.90	2.50	.111	.173
N. Y.—N. J. .	35	2.50	1.00	2.60	.100	.146
Alabama. . .	36	1.00	.25	2.75	.035	.104
Norway . . .	35	2.50	2.00	3.60	.128	.174

* Findlay on Iron Ore Costs.

Although these figures are based on prewar costs which may not come again notwithstanding the fact that this has occurred with other metals they are nevertheless still relatively comparative. The war did not alter the competitive conditions surrounding each region.

The question of vast reserves is a financial as well as a commercial consideration to any particular operation. When capital is invested in any project it must necessarily be protected by continuity of operation. In the industrial mineral business where the yearly return on the capital is relatively small, that continuity of operation must cover a considerable period of years and the greater the production capacity, the greater must be the reserves upon which their continued life is founded.

The capital necessary to be invested in industrial operation of this character is large, and an examination of relationship between capitalization and production capacity of typical iron and steel concerns will show that the invested capital is in proportion to the simplicity or otherwise of the processes undertaken. The lowest capital per ton of capacity is exhibited by those plants producing pig iron only, and the greatest capital per ton by those producing quantities of semi-finished products and holding large reserves of raw material, and varies from $9.00 to $100.00 per ton of pig-iron produced per year. Inasmuch as the market for pig iron is amply catered for by existing production capacity in Canada, it follows that any new iron and steel venture would ultimately, in order to protect its own existence, be compelled to reach into semi-finished production, and therefore, the capital that would be necessary is nearer the maximum than the minimum.

The assumption under these circumstances is that a reasonable capitalization would be $15,000,000 and at a fair rate of amortization on such an outlay would be 5 percent per annum, assuming also that the concern is in addition earning a proper and reasonable rate of interest. At that rate of interest, 41 years would be required to return the capital. This is the minimum, as there might conceivably be years in which the amount was not earned, and so a total life of 60 years is not unreasonable, as a future outlook. A plant this size would call for three furnaces, requiring a yearly ore-feed of 300,000 tons, with allowance for lost time and shutdowns, in turn requiring a reserve of 20,000,000 tons over the life of the plant. This should be the known reserve, leaving "possible" and "probable" figures to take care of future expansion.

From the above is clearly evident the vastness of the reserves that should be in sight for a steel operation. On the other hand, the production and sale of ore as ore, requires no such capital outlay, but it is hampered in a competitive sense by the necessity in Central and and Eastern Canada of competitive production with Lake Superior or Wabana ores. This implies equivalent or greater quality. High-grade ores can always be marketed, but this must be done at prevailing prices, and they must be consistent in ore content and furnace qualities. The lower the ore-content the greater must be the tonnage in sight.

Quality of the Ore.

The commercial limitations under the head are two in number; a standard in iron-content and consistency in quality. The application of this standard is well apparent from the series of analysis printed herein of various well-known operating districts.

The standard in iron content ranges from 47%–48% iron and upward. It averages in the aggregate probably 50%. Below 50% and down to 47%, competitive commercial costs must be compensated by some other factor, cheap mining, low cost of transportation, or a chemically and physically readily-smelted ore. Below 47%, methods of manufacture demand that some process of beneficiation or raising the unit value of the iron to that percentage or over be undertaken, and there is added to the manufacturing costs another figure which has to be offset by other compensating circumstances.

Manufacturing processes also demand consistency in the ore used so that ease of operation of the furnaces be obtained, in order that cost may be as low as possible, and that the quality of the product be uniform. Certain processes of manufacture have been developed for certain classes of ore but consistency in each class of ore for each process is always desired. It has not yet been found commercially possible to run a steel plant on the lines of a custom-smelter, buying ores of varying quantity and quality, although it is possible to blend two or three classes of ore, provided each class is available in steady quantity and quality.

So far as known, Canada possesses no ore-deposits that possess the necessary requirements to warrant being classes under the first definition given, and to that extent she is dependent upon the ores of other lands. But she is extremely fortunate in having close to her borders two deposits—Lake Superior and Wabana—which compare in first magnitude with any in the world, ore-bodies which possess vast reserves of consistent high-grade ore, together aggregating 6,250,000,000 tons, a not inconsiderable share of the world's ore reserves, from which ore can be laid down at production points in Canada well within the competitive limit.

Beneficiation of Ores.

By this term is meant the raising of the quality of the ore as originally mined to the status of a commercially-saleable ore in competition with other areas naturally endowed with the requisite quality characteristics. It implies that in addition to the mining cost there is added at the mine or other convenient point an additional cost of operation. Beneficiation is necessary in the marketing of millions of tons of ore now being produced, and presupposes a more or less intricate technical process.

The tonnage of ore produced that is lower than that suitable for straight production is very great. In Great Britain it represents normally 60-65 per cent of that ore used by steel industry, and as mined is classed as below:

Iron Content Percent	1910 Tonnage
25-30	8,895,121
30-35	2,035,963
35-40	41,808
40-45	14,202
45-50	284,158
50-55	981,943

The proportion of low-grade ores used in British furnaces was much increased during the war because of enforced reliance on domestic ores.

Without positive knowledge it is agreed that Canada possesses, mostly in Western and Northern Ontario, considerable reserves of ores of a class that in general requires beneficiation before they can become competitive factors in the industry. Laying aside the want of definite knowledge upon developed tonnage of definite character, i. e., million tons of magnetic concentratible ore, 25, 30 and 40 per cent, or million tons hematite, and definite knowledge of the mixtures of the two that exist, it is nevertheless apparent that the question of the possible utilization of these ores is an important one.

The figures already recited in these pages and comparative as to results even allowing for the increase in cost of recent years, indicate that the limiting costs allowable for all expenses including beneficiation are extremely meagre. Sweden, to be competitive with other countries, has to deliver her ores at the furnace at 9c per unit, in which figure has to be included transportation and mining, as well as beneficiation. As the first two are reputed to equal 7c per unit, there is only 2c per unit allowable for the secondary process, making a possible limiting cost of $1.75 per ton, provided freight and transportation does not amount to more than $2.85, and mining $1.75, unless exceptional conditions of mining and transportation develop or the discovery or invention of an extremely economical concentrated method be consummated, it is not at present commercially profitable to produce these lean ores in Canada. Such ores have also a narrow range of transportation possiblity.

Despite these statements, however, these ores remain a potentially great future asset, and looking to that future, two means of forcing their development are available. The first of these is through payment of a bounty on either the ore mined, or steel produced from Canadian ores. In effect, a bounty to be of any use, amounts to the Government paying part of or the whole of the cost of concentration, and to be successful, should be arranged on a sliding scale based on the quality, since otherwise if given as a fixed rate per ton, it merely allows say 45 per cent ore to enter the market as well as 50 per cent. If increased a little more, 40 per cent ore becomes minable, and 45 per cent ore mining becomes plutocratic. A bounty, therefore, that is based on a straight tonnage basis becomes an artificial aid to a few ore properties with the grade of ore to meet or absorb the bounty and does nothing for the question of the development of a commercial ore-field as a whole. But the main objection to a bounty lies in the necessity of its perpetuity throughout the years in which existing ore sources continue to produce the same grade of ore, since to do otherwise would be merely to promote the investment of capital in a new branch of the industry and leave it later, if the bounty is removed, to be lost through competition that could not be faced. A bonus would in all probability result in a temporary discovery and operation of small ore-bodies ill fitted to sustain a steel industry, a class of mining that would inevitably fail when the bounty was removed, and the giving of a bonus would not affect the merchantable qualities of Canadian ores. The artificial stimulation of the production of ores of uncertain quality and doubtful quality will not indicate the way to use these ores.

Looking at the subject along broad national lines the solution to the question does not depend upon bounty considerations, but points rather to a pooling of the interests concerned to.

First: Gather and analyze the information now available on all areas as to quality, quantity and character of the ores, with a view to ascertaining

(a) The reliability of the information.

(b) The actual proved tonnage of each of several classes of ore and the mining and transportation conditions surrounding each class, and

(c) The potential reserves of each of the classificatons of ores adopted.

Second: Based on the above, the question of their commercial beneficiation should be made subject of a careful research, followed by tests in a laboratory and experimental plant, conducted first on the greatest tonnage of ore of the highest quality relatively available that permits of the easiest means of concentration, and carrying the work successively to lower classifications of ore.

It is true that private enterprise supported by a bounty could possibly reach the same point, but for the several reasons just cited, it appears that the money which would otherwise be paid out in bounties, would be spent with greater ultimate benefit to the possibilities of the industry along the lines written above. It may be that the final result might take the form of a customs beneficiation-plant, but before that point is finally reached, a vast amount of work remains to be accomplished and until it is accomplished, here is one class of mineral development in which the investment of more capital should be discouraged.

Electric Smelting.

So far attention has been directed to steel production by fuel reduction. There remains the possibility of power reduction. Only in one region, Montreal and vicinity, are the natural conditions such that the underlying factors can be considered as present in reasonable volume and availability. Here there is approximately 575,000 W. H. P. installed, capable of expansion to 800,000 with as much more undeveloped current., so situated that waterborn ores from Wabana or the Lakes could readily be transported to the plants.

The possibility of an electric-steel plant depends upon:—

(a) The creation technically of a process capable of producing steel commercially competitive with the fuel-produced product.

(b) Available ore-resources of prime quality.

(c) A sufficiency in water power.

(a) Technically, the production of ores to pig iron and directly to steel has been accomplished, and commercially it has been a success under conditions favorable to the operation, the greatest and possibly the only examples being the various

processes developed mainly in Sweden. Under Canadian conditions, the process would be unsuccessful by reason of (a) the cost of power, (b) the cost of the fuel, and (c) the competitive conditions that exist. Until it is demonstrated that coke and a 50 per cent ore instead of a 60 per cent ore can be reduced to pig iron on a basis commercially comparable with blast furnace reduction, the expenditure of capital in electric smelting of known Canadian ores need not be further considered.

B. COAL RESOURCES.

The coal resources of the Dominion are understood to be vast, being in fact 17 per cent of the world's coal reserves. Arranged by provinces, the disposition of the coal is as follows:

Province	Tons
Nova Scotia	9,718,968,000
New Brunswick ..	151,000,000
Ontario	25,000,000
Manitoba	160,000,000
Saskatchewan . ..	59,812,000,000
Alberta	1,072,627,400,000
British Columbia .	76,034,942,000

Coking Coal

The steel industry, however, is concerned with coking coal only as a reserve by provinces. Figures for this class of fuel appear below:

Province	Tons	Distance Apart Miles	
Nova Scotia	9,718,968,000	....	...
Alberta	57,859,400,000	3213	...
British Columbia .	66,620,242,000	3855	600

Other districts contain coals that will coke but the necessity of production demand the best grade of coal available.

The amount of coke consumed per ton of pig iron or steel produced, as between imported and native ores, assuming the latter name to cover for these purposes the ore received from Newfoundland, is as follows:

	Imported Stock			Semi-Native Stock		
Year	Lake Superior Imported Ore	Imported Coke	Tons Coal Per Ton Of Ore	Newfoundland Ore	Native Coal	Tons Coal Per Ton Of Ore
1918	1,298,421	861,522	1.51	848,574	561,135	1.51
1917	1,200,885	723,657	1.66	883,346	634,962	1.39
1916	952,538	645,488	1.48	1,012,060	712,715	1.42
1915	595,037	486,022	1.23	868,451	578,743	1.50

Travel of Ore to Coal.

From the figures presented, two facts emerge; first the ratio of the tonnage of fuel to ore; second the difference between the tons of coal per ton of iron produced on imported and native fuel.

Since there is required one and one-half tons or over of coal per ton of pig iron produced, it follows that transportation rates being relatively equal, ore will always in the interests of economy be carried to the coal and consequently the location of steel plants should logically be in the coal fields. On this principle there is thus segregated three areas in Canada:—Nova Scotia; British Columbia and Alberta, interior region; and British Columbia coast region, that are fundamentally correct in this respect.

Natural conditions in the occurrence of either coal and ore can upset this dictum, as for example of a water-borne coal and a land-transported ore. In this case, the reverse would be true, in that coal could economically be carried to the ore owing to the different in cost of water transportation. It is obvious also that the ratio of the fuel required to ore will also affect the problem of the most economical plant position, since should the tonnage of coal required be less the nearer is the equality in distance between points of origin of raw materials.

The ratio of tonnage of fuel to ore is, however, an important one to the steel industry on another question, namely the extra coal required to smelt the ore. This is due partly to the ore and partly to the coal, and it is naturally a vital factor in competitive costs of production. Were things otherwise equal, this would tend to restrict greatly the competitive area of Canadian native-produced iron and increase correspondingly Canadian foreign-produced iron.

Summary.

Out of the figures, facts and fancies discussed in the preceding pages, the following summary helps to crystallize the ideas deduced and expressed. Most of the deductions made are common arguments in contemporaneous discussions in any question of the growth of the Canadian iron and steel industry, but their direct relationship to the expansion of the country in the commercial sense and indeed to the building up of a world trade may not have been so well appreciated.

1. It is almost universal practice and economical production in steel making to carry the ore to the coal. This indicates basically three main iron and steel industrial theatres in Canada:—namely Nova Scotia, Alberta and British Columbia.

2. There are exceptions to the above rule based upon special economic conditions, these conditions existing in the Ontario Lake regions through the combination of situation in the pathway of a stream of high-grade ore, a tariff restriction on the importation of iron and steel and products, and elimination of tariff on imported coal used.

3. The travel of ore to coal is under modern conditions world-wide and must be increasingly so, a fact that will operate to the benefit of Canada increasingly so in the future.

4. A steel industry must be fed by ore-deposits of first magnitude to be commercially successful, but the fact that there exists no such known commercial deposits of iron-ore within the boundaries of the Dominion is no drawback to the growth of a steel industry provided the other basic factor, namely a sufficiency of coking-coal, exists.

5. While the area examined for possible deposits of ore of the size demanded by modern industrial operation is only a part of Canada, unfortunately it is that part which is within commercial transportation distances.

6. Canada's steel industry is fed from two for-

eign deposits—one the Lake Superior District, and the other in Newfoundland.

7. These two deposits, both within a comparatively short distance of her borders, are together not exceeded in magnitude by any other known ore-deposit in the world so far discovered.

8. The quality of these ores is of first grade and exceedingly uniform.

9. The drain upon their resources is great, but no more proportionately than upon the resources of other deposits by other countries, with the one exception of Brazilian territory.

10. The Lake Superor ores can overcome economically any ore mined within the same distance from the Canadian shore of Lake Superior so far known, and these ores can supply any plant in Ontario.

11. That going westward Lake Superior ores could almost reach Winnipeg and could probably enter that city on a competitive basis, could it meet there a proper coal-supply.

12. There exists unknown but potentially vast ore deposits of secondary character, the utilization of which is dependent on:—

(a) A research into methods of beneficiation suited to the production of a commercially saleable and furnace-manageable ore therefrom.

(b) The commercial competitive realization of the above.

13. The importance of accomplishing the work under clause 12 is so great that it should become a nationally conducted and supported work of research.

14. Direct production of steel from ores through the use of water power is an evolution of the future that should be closely watched. Its success is dependent upon:

(a) The proper association of the required power and the ore.

(b) The successful evolution of the present or future processes of electric smelting to a status of competitive commercial development.

15. Requirements under 14 are most important to the Province of Quebec in conjunction with her known waterpowers and either Newfoundland ores or other possible ores from the northern shore of the Gulf of St. Lawrence in Quebec.

16. The commercial advantages of steel production lie with coastline plants as this permits of cheap transportation of both raw materials and products.

17. Unless there exists a market in the hinterland of the plant such an operation cannot penetrate commercially far inland against inland competition but must turn its eyes seaward for the disposal of the major portion of its production.

18. In this respect the east and west of Canada present different pictures. The eastern market is established, is growing, and commercially is relatively equal in size of consumption to any elsewhere. The western market is potential and relatively unequal and unknown as to consumption.

19. On the basis of the facts, there are four main steel industrial areas in Canada worthy of attention.

(a) Eastern Canada (including Nova Scotia, Quebec and Eastern Ontario).

(b) Western Ontario.

(c) Central Alberta.

(d) Coast of British Columbia.

20. The East presents the following features:

(a) The industry is well established, and its growth can be taken care of by the expansion of existing operations or the establishment of new ones both based on existing commercial and new material conditions, such expansion being commendable as and when the growth of the population and industries based thereon warrant.

(b) A secondary development is possibly foreshadowed still, in the future, in a portion of the region along special lines through the development of electric smelting and its possible utilization of more difficult ores.

(c) Any change in the fundamental facts upon which the industry is based in this area is dependent upon a successful process of beneficiation of native ores and the slowly-changing conditions of commercial production of Lake Superior ores, a coming change that has been foreshadowed by experiments under way in connection with the lower grades of these same ores.

21. The Western Ontario Region presents the features of:

(a) Being a western extension of the region described under clause 20 based on the same underlying commercial principles and raw material conditions ,and facing a western market still undeveloped.

(b) This extension would be commercially eliminated should the potentiality of the third main region become a reality.

22. The Central or Rocky Mountain Region presents the following features:—

(a) As a steel-production region, its possibility is entirely potential and is dependent upon:

1. The future growth of the presently small well-defined interior market of great future promise.

2. The discovery within reasonable operation limits of commercial ore-deposits of sufficient importance to meet the requirements of the standards laid down.

(b) This region has within its borders the second and the greatest asset of any of the regions in its great coal supply.

(c) It also possesses the nucleus of a compact internal market.

(d) Within operative commercial limits the growth of the industry can be commenced in a small way and progress with the development of the region.

23. Coast of British Columbia. This territory presents these features:

(a) There is within the boundaries of this region the third of the coal assets of the Dominion. These assets are located on water transportation.

(b) The region could be independent of internal or native markets, and its potentialities depend upon a definition and examination of the markets in Pacific waters.

(c) It is a development that could be consummated with either native or foreign ores.

(d) The commencement of the industry in

new of these conditions would probably have to be upon a considerable scale.

24. By reason of the existence of coalfields upon both coasts, Canada's position in the steel industry should be in the future important. With the single exception of Great Britain, there is no other country so favorably situated in regard to natural position.

25. The further investment of capital in either existing iron-ore developments, or possible new ones which present the following conditions, should be discouraged:

(a) Deposits of a commercial standard which are not within one hundred and fifty miles of water transportation.

(b) Deposits which require beneficiation.

(c) Deposits which are visibly small in extent, or uncertain in quality.

26. The utilization of ore-bodies which require beneficiation or the electric reduction of iron-ore to pig-iron or direct to steel, are problems to be considered first technically for many years before capital investment should be allowed.

27. No capital investment should be made in new plants destined for the production of primary products competing in existing production areas, nor in direct electric-smelting plants, and capital invested in non-producing areas should only be undertaken after painstaking investigation, on the understanding that the amount ultimately involved is huge.

28. These facts are cited because the capital which might be invested along these lines will produce nothing that benefits the growth of Canada, and that capital can be much more advantageously utilized elsewhere and in other lines.

PRODUCTION OF IRON AND STEEL IN CANADA.

Pig Iron and Ferro-Alloys.

(Abstract of Monthly Report of Dominion Bureau of Statistics).

The production of pig iron and ferro-alloys in Canada during the month of April declined still further to a new low level for the year, the entire output for the month amounting to only 39,693 long tons. The output of basic open hearth iron suffered most, dropping from 35,662 tons in March to 15,971 tons in April, all of which was made by firms for their own use. The increase in the production of foundry iron, noted in the March report, was continued in April, when the output rose to 22,929 long tons. This represents an increase of 6,133 tons over the March production. The greater part of the increase was produced for further use in processes of manufacture, the amount credited to this item being 6,165 tons in March, as compared with 11,544 tons in April. Foundry iron made for sale rose from 10,631 tons in March to 11,385 tons in April. No malleable iron was produced during the month, nor was any low phosphorus pig made in electric furnaces.

Ferro-alloys production amounted only to 793 tons during the month, which is a further loss of 156 tons. No spiegeleisen was made in Canada in April.

At the close of the month six furnaces were active and fourteen idle. This is a net gain of one furnace. At the close of March the Algoma Steel Corporation had only one furnace in operation, but at the close of April three furnaces were in blast. The Canadian Furnace Company at Port Colborne reported its furnace as idle at the end of the month. The remainder of the list was unchanged. Two furnaces were operated by the Steel Company of Canada at Hamilton, Ontario, and one by the Dominion Steel Corporation at Sydney, Cape Breton.

The average daily production of coke and anthracite furnaces in the United States during April was only 39,768 tons per day, and was the lowest output recorded since June, 1908.

Steel Ingots and Castings.

The April production of steel ingots and castings in Canada established a new low record for the year when a total of only 27,381 long tons was made. The previous month's output was nearly 53,050 tons. Most of the loss was in basic open hearth steel, the production under this item receding from 50,946 tons in March to 25,252 tons in April, all of which was made by firms for their own use. Only 191 tons of electric steel ingots was produced and of this 172 tons was made by firms for their own use in further process of manufacture. Thus, the total quantity of steel ingots made in April was 25,443 long tons. The total for March was 51,318 long tons. Direct steel castings increased from 1,732 tons in March to 1,938 tons in April. The increase was principally in the production of electric steel, which rose from 1,482 tons in March to 1,683 tons in the month under review. Of the latter amount 1,456 tons was produced directly for sale. More converter steel was also made during the month, 109 tons being reported as made for sale and 15 tons for further use. The output of basic open hearth steel castings declined from 152 tons in March to 131 tons in April.

In the "Monthly Report of the Trade of Canada" prepared in the External Trade Division of this Bureau, a section is devoted to imports of "Iron and its Products." Under this heading all commodities consisting principally of iron and steel are listed each month, the quantities and values of the imports under each item being shown opposite the names of the countries from which each commodity is imported. The importations of "Iron and its Products" thus defined amounted in value during the twelve months ending March, 1919, to a total of $192,527,377, of which $185,116,309 represented the value of products of United States origin. During the next twelve months the total imports were valued at $186,319,876, and of this amount $178,661,606 was spent for United States products. In each of the two years just reviewed the entries under the same headings as before of iron and its products from the United Kingdom amounted to a little over six million dollars in value. During the twelve months ending March, 1921, Canada imported iron and steel products valued at $16,698,085 from the United Kingdom; $226,862,465 from the United States and $2,065,903 from other countries, a total in all of $245,626,453. It will be observed that imports of iron and steel products during the twelve months ending March of this year showed an increase in value of 32 per cent over the previous year and 22 per cent. over the valuation credited to the same items for the twelve months ending March, 1919.

H. J. Freyn, President, Freyn, Brassert & Company, Chicago, Ill., sailed for Europe on an extended business trip through England, Belgium, Holland, France and other countries. Mr. Freyn is expected to return in October.

Correspondence

IS THE MACHINERY TRADE WAITING FOR "SOMETHING TO TURN UP."

THE EDITOR "Iron and Steel of Canada."

Sir,—Once upon a time, here in Canada, we had a good steady demand for the products of our machine shops, from jobbing stops to auto factories, and I am not referring to the "Shell Game," but before then. In those days it was a common saying, and more nearly true than such sayings usually are, that no man need want for work in this country. Such reflections now read like the fairy stories of our youthful days, and looking backward in contrast with today, makes one feel that we must have had a fairy god-mother who has since deserted us for our ingratitude.

It is not necessary to dwell upon the mournful situation of today which is all too well-known. The silence that has decended upon our industrial communities, and the meeting in the streets with men whose presence there in the day-time is unusual, are continual reminders that the times are out of joint. What I do wish to dwell upon is that so far as my knowledge goes there has not been, and is not being, any serious attempt made to get back to what I think I am justified by the experience of past years, in calling normal times.

What has been the rule during the greater part of our history, must be the normal state of affairs, and work for every one nearly all of the time, having been the condition in this country, it follows that this is the normal condition, and it should be within our ability to restore it, as all the tendencies will be in favor of a return to normal.

The fact that one of the tribes inhabiting this globe has passed through one of its periodical spasms of insanity, and caused the destruction of a large part of our material wealth before it could be placed under restraint, is the cause of much of the abnormality now existing, but is no excuse for supinely waiting for the return of normality. I am very keenly aware of the magnitude of the problems to be solved, and have no intention of denying the skill and delicacy with which the solution must be worked out, but my reading and study of the progress of affairs leads me to the conclusion that the machinery trade, at all events, is simply waiting Micawber-like for "something to turn up."

I am quite aware that some firms are energetically pursuing any thing that looks like a prospect for an order, and without in the least desiring to discourage their efforts in this direction, would point out that the orders they are after are for goods that will be purchased in any event, and the order will be placed if not with them, with some other firm, and as far as the general situation of the country is concerned their efforts are purely selfish and do not increase the total volume of employment. The point I wish to make is that we must devote our energies and intelligence to the getting back of the whole trade to what is after all only its normal condition, before we can consider that we are displaying signs of human intelligence. I would like to venture the opinion, that if the same skill and energy that is now devoted to fighting between ourselves for the small orders that are going, was combined and put to work to get back to normal, this one step alone would carry us a long way on our road, as it would inspire confidence in those who are now staying out of the market through panic, and so remove what is in my opinion the biggest obstacle, namely lack of confidence in the future of our country.

That there is a serious lack of confidence on the part of those who have capital to invest, is clearly shown by the fall in the prices of all stocks on the Stock Exchange. Taking the shares of the two principal steel companies traded in on the Montreal Exchange, we find that the Steel Company of Canada common stock sold at 88 in December 1919, is now being sold at less than half the price, namely 43. And Dominion Steel sold at 75 in December 1919, is now quoted at 24, or less than one-third of its highest price.

The problem before us is first to determine what is preventing the machinery trade getting back to normal, and secondly what steps we can take to expediate the return of normal business. It must be admitted that the problem is too large for any individual efforts, and will require the combined intelligence of the whole trade to accomplish any useful results. On the other hand the experience of the last two years would seem to indicate that it is useless to wait longer for matters to right themselves, a very little while longer of this idle waiting for something to turn up, will produce such a state of destitution upon a large percentage of the population as to threaten civic disorder resulting from wide-spread hunger, and blame for which would be laid at the door of our leaders because they have failed us just when efficient leadership was most essential.

While I cannot pretend to be able to offer a detailed solution of the difficulty, still there are certain broad aspects of the situation from a study of which the road to a solution may be indicated. In the first place, unfortunately for us, the machine trade is practically at the apex of our present civilization, that is, any lowering of the standard of civilization, will injure the machinery trade first. This leads to the thought that as at least half of the population of the World is living under primitive conditions, the leading of these people to a civilization more nearly equal to our own, should produce a demand for a quantity of machinery equal to the amount now in use, which demand would give employment to all our skilled trades for this generation at least. How these people are to pay for the machinery will be require to be worked out, but as a machine will pay for itself in the increased production it will give, the question cannot be insoluble.

With regard to our domestic trade, the normal demand for goods is held up by the expectation of further reductions in prices in the near future, which prevents the purchase of anything beyond what is immediately required. It it can possibly be done, the fixing of prices for a reasonable period ahead will remove this obstacle and permit the proceeding with a volume of construction which would start up the bulk of our factories and as the output of really new constructive work, as distinct from machinery for destructive purposes, has been far below normal since 1914, there must be a large latent demand that has accumulated during these seven years.

The fixing of prices for the future, is a problem that is beyond the capacity of any single manufacturer, because into his costs enter so many other costs over which he has no control such as raw materials, transportation, labor, taxes, interest on borrowed money, etc. It should be feasible, however, if all parties, labor, manufacturer, and banker, meet, to solve the problem, in the successful solution of which they are all equally interested, to arrive at some fixed prices for the

part each plays, which will permit the fixing of the price of the completed product on some stable basis for a year or more.

As the game is being played now, each party whose wages or other gain is at stake in fixing the prices of the finished product, may be quite satisfied that the total price is too high for the market, but each party is afraid that the others may escape their share of the loss, and so we have the result as a little cut off the cost here, by one party, and a little nibbled off there, by the other, each being afraid to go too far for fear of the other getting an undue advantage.

The final result is that the prospective buyer decides to stay out of the market, until he is absolutely sure that the nibbling at the price is all done, and as there is no way of knowing just when the price has reached rock bottom, there is no end in sight to the process. It would be far better to make a good substantial cut by all parties, in fair ratio to each other, at one stroke, and get right to the bottom at once.

Those to whom I am particularly addressing myself, namely the people dependent upon the machinery trade, must not overlook the fact, that the demand for machinery is dependent upon the continuance and advancement of the present system of civilization, which is after all an artificial one, and therefore not self-sustaining. If this civilization is to continue and improve, which is what we all desire, although we may have different ideas as how it may be improved, it behooves us to bestir ourselves to hold what we have gained, as the pressing question at the moment is not to advance, but to avert the very real danger we are in of slipping back to a lower civilization if we do not combine together to hold our gains and overcome the drag backward to barbarism.

Let those who do not appreciate the danger of a reversion to barbarism, consider what will be the effect of another year of the present unemployment, and bear in mind that we have reached a stage where not one of our most experienced business men will venture a prophecy of how long this slump may last, beyond a guess that it may be a year, or it may be three years before we begin to approach normal times again. I venture to say that I do not believe our civilization can stand the strain of even only one year more of this disorganization.

To avoid the calamity that is close upon us, will demand the exercise of all the intelligence of which we are capable, and at the same time and more important still, of a display of altruism, and a spirit of comradeship, the lack of which between the employer and the employee in the past has been greatly responsible for our present situation. All are in the same boat, and unless we all pull together all will be lost.

The onus of beginning the proceedings is upon those who by virtue of their talents, have been raised to positions of responsibility, and they must for a time forget the selfish interests of the individual company by whom they are employed, and join together in a combined study of the whole situation, and, as in the final analysis, the problem is simply one of getting up to where we were in 1914, it should not be beyond their collective ability.

JOHN S. WATTS.

New Glasgow, N.S.

U. S. STEEL CORPORATION REDUCES PRICES AND WAGES

Chairman Gary, of the Steel Corporation has announced a reduction in prices to conform with recently announced schedules of Bethlehem, Republic, and other independents. He also announced abrogation, July 16, of the so-called "basic" or "overtime" day put into effect during the war as an emergency measure.

Elimination of overtime day, according to which the men received "time and a half" for time worked in excess of eight hours, will reduce daily wage for 10 hours from about $4.05 the present rate, to $3.70, a cut of over 8½ per cent.

Where the 12-hour shift is in operation, as still the case in certain departments of some corporation mills, the financial saving through elimination of the basic day in figuring pay will, of course, be greater. At present rate of 37 cents an hour, with time and a half for overtime, the wage for 12 hours is $5.18. On the new basis, straight pay for 12 hours will be $4.44, a saving of two hours' pay, or over 14 per cent of the old rate.

Prior to the corporation's wage cut May 16, the daily rate for common labor was 46 cents an hour, or $5.06 for a 10-hour day on the eight-hour day schedule. This rate, put into effect Feb. 1, 1920, was the highest ever paid by the corporation. The new rate just announced, giving $3.70 for a 10-hour day, represents a reduction of over 26 per cent from peak wages for 10 hours' work, and an even greater reduction in the case of 12 hours' work. The pay in 1915 for a 10-hour day was $2.

The corporation's cut in prices brings the entire trade once again to a stabilized level, such as existed on April 13, when the corporation's last cut went into effect. Then, as now, action of the corporation followed quickly an announcement of a new schedule by one of the leading independents. The price cut of the corporation at that time, however, was more significant than today's, as prior to the April 13 cut the corporation had been adhering strictly to the Industrial Board level established in March, 1919, while in the present case it has been generally believed for some weeks that the corporation has been meeting competition of independents wherever necessary to protect its business. Official confirmation of such action, however, has been forthcoming only in one or two products.

The corporation's new prices, compared with those of April 13, and the Industrial Board level, are as follows:

	July 7	April 13	Industrial Board level
Bars	$1.90	$2.10	$2.35
Structural shapes	2.00	2.20	2.45
Plates	2.00	2.20	2.65
Sheet bars	35.00	38.00	42.00
Billets, 4x4	33.00	37.00	38.50
Slabs	34.00	38.00	41.00
Blue annealed sheets	2.65	3.10	3.55
Black sheets	3.50	4.00	4.35
Galvanized sheets	4.50	5.00	5.70
Tin plate	5.75	6.25	7.00
Skelp	2.00	....	....

Later, on July 8th, the Corporation announced reduction from $2.00 to $6.00 per ton on standard steel-pipe, and from $4.00 to $12.00 per ton on boiler tubes, wire nails are reduced from $3.00 to $2.75 per keg, and plain wire from $2.75 to $2.50 per hundred pounds.

Gurney Foundry Company, Ltd.

A Leading Manufacturer of Stoves, Ranges and Domestic Heaters.

By A. R. R. JONES.

Few, indeed, of our national Canadian industries have been more searchingly tested by time than the Gurney Foundry Company, Ltd., has been. And few, if any, have stood time's rigorous testing better. This business, which is well known throughout the Dominion, was founded in the year 1843 by the grandfather of the present President of the Company. Its birthplace was Hamilton, Ont.,—a city by the way which has been the scene of the laying of the foundations of not a few of the manufacturing concerns which today loom largest in the industrial life in Canada.

From its earliest inception the business progressed steadily, and in the year 1868, a branch of it was established in Toronto. Later on, this became the Company's principal establishment, and the plant at Hamilton was relinquished. Some fifteen years ago, the Company built at West Toronto—some five or six miles from the centre of the city—what is still its largest plant. It possesses another plant also in Toronto—at 500 King Street West where its chief executive offices are also located.

Montreal Plant And Subsidiary Organizations.

Further, the Company, last year, added to its plants, its present Montreal undertaking, as to the layout, etc. of which something will be said later. This plant is conveniently and admirably located at St. Laurent, just a few miles distant from Montreal.

The Gurney Foundry Company, Ltd., has two subsidiary organizations. One of these is the Gurney-Massey Company, of Montreal, which is a distributing house for the Company's products east of Brockville, Ont. The other is the Gurney North West Foundry Company, of Winnipeg. The last-mentioned concern is a distributing house for the Company's products in the Western provinces, with the exception of British Columbia. For British Columbia the Company has a separate distributing house at Vancouver, called the Gurney Foundry Company, as it does not constitute a separate company in itself.

Then, affiliated with the Gurney Foundry Company, there is a sister company, manufacturing precisely the same products, and known as the Gurney Heater Manufacturing Company, of Boston, Massachusetts. The plant of this sister company is at Framingham, Massachusetts, and has its offices in New York, Philadelphia and Washington. This, it should be made plain, is an entirely separate company, but, as has been noted, its products are the same as those of the Gurney Foundry Company, Ltd., and the same remark applies to its principal offices.

With regard to the Montreal plant, at St. Laurent, this, as mentioned above, was added to the Company's undertakings in 1920 when the physical assets of the Canada Stove Company were acquired. The Vancouver house was established so long ago as 1897, and the establishment of the Montreal distributing house was prior even to that, having taken place about thirty five years ago, while the North Western distributing house was established in 1907.

Company's Officers And Employees.

Mr. E. H. Gurney, the grandson of the original founder of the business, is President of the Gurney Foundry Company, Ltd., and of all the companies affiliated with, or subsidiary to, that undertaking. Mr. William T. Isaac, of Boston, Massachusetts, is Vice-President, and he is also the general manager of the Gurney Heater Manufacturing Company, of Boston, the American sister company. Mr. W. R. Gibson is the general manager of the Gurney Foundry Company, Ltd., while Mr. Roy Oaton is the secretary, and Mr. F. F. Skinner, the treasurer.

The company's employees at the present time number about 1,000. As business can scarcely be said to have been at normal, in the lines which the Company manufactures, for several years, the fact that it maintains so large a staff of employees, under present business conditions, is eloquent testimony as to the volume and scope of its manufacturing operations. The Company deservedly enjoys the reputation of being an exemplary employer. As to its care in fostering the recreational side of the lives of its employees, a word or two will be said presently in describing the big plant at West Toronto. One often hears it said that it is a matter of great difficulty to do anything appreciable in the way of fostering this recreational side in the case of workers at plants situate in, or adjacent to, a big city. But the Gurney Foundry Company's experience certainly contradicts this. For the Company takes great pains to render its employees contented and comfortable, and is rewarded by the spirit of loyalty to, and pride in, the concern which the latter evince.

A Very Wide Range of Products.

Exceedingly wide is the Company's range of products. To put the matter in a nut-shell, it may be said that among its products is included practically everything essential to heating and cooking purposes. The high reputation of its products for durability, and all else that pertains to a rarely high standard of quality is, of course, Dominion-wide. Not only that, but it extends far beyond the confines of this country. Every kind of stove and range and furnace is turned out from the Company's plants. So is everything for steam and hot water heating—indeed, the Gurney-Oxford boilers and radiators are a household word for excellence. The Company also operates a contracting department which has put the kitchen apparatus into most of the leading Canadian hotels, among which may be mentioned the Chateau Laurier, at Ottawa, the Fort Garry, at Winnipeg, and the Royal Alexandra, at Winnipeg. It has also put its various lines of manufacture into many of the principal hospitals in the country, including the Toronto General Hospital.

In a talk which the writer had the other day with the Company's President, Mr. E. H. Gurney, the latter, in reply to a question as to business conditions and prospects, gave a reply which, in view of the very general depression of which one hears and sees so much—and certainly not least in Toronto—just now, is very far from discouraging. "We are," he said, "doing more business than we were doing, at this time of year, in 1919, though certainly a good deal less than we were doing, at the same time of year, in 1920. I should add that we are experiencing a slow, but, at the same time, a steady, improvement in business each month. And

this improvement, both in percentage and in total volume figures, has been experienced since the first of the year.

The Big Plant At West Toronto.

The large Boiler and Radiator plant of the Gurney Foundry Company, Ltd., is located, as has been mentioned above, at West Toronto. In the opinion of experts, this plant is an ideal one, alike in the suitability of its location and in the admirable arrangement of its various manufacturing units.

The site covers approximately 12 acres of ground and the plant proper, consisting almost entirely of one storey buildings of a modern type for foundry practice, covers approximately 6 acres. The foundry proper has an area of nearly 2 acres and is supplied with metal from three cupolas, one of which is the largest in Canada. Moulding machines are extensively used throughout in this department.

In order to supply a large plant of this type with core sand and iron, the most modern handling facilities have been installed. For example, the mixed core sand and oil are never touched by hand until they are in the coremaker's bench. This is a typical example of the "up-to-dateness" which characterizes every depart- of this well-ordered plant.

The rough castings go to the cleaning and inspection rooms which constitute a most important department because it is essential that castings which are going to carry water and steam pressure in private buildings throughout the country shall be perfect.

Then the castings pass on to the machining and assembling department where vigilant inspection is continued, and then to the warehouse and shipping rooms.

The whole plant is so arranged that raw material enters at one end and comes out at the extreme other end of the Plant ready for shipment. There is a slight grade throughout the Plant so that the carrier system operates practically without power.

Shipping Facilities And Recreational Activities.

In the case of a concern of such magnitude, and one of which many of the products are of a very heavy kind, it is naturally of the first importance that the shipping facilities should be of the best. In this respect, the West Toronto plant of the Gurney Foundry Company, Ltd., is exceptionally fortunate. Its shipping facilities generally are as good as they could be. They are of such a nature that eight of ten freight cars could be handled at one time, while there are separate facilities or "docks" for the loading of trucks for local business.

Mention has been made of the care for the social and recreational side of its employees' activities which the Company evinces. In connection with the West Toronto plant a cafeteria is operated which constitutes a great convenience to the workers who are enabled, by its means, to obtain excellent food at low prices. Then there is the important part which the playing fields bear in the social life of the workers. These are very extensive and much patronised. They afford the workers in the plant abundant opportunities for healthy and well-timed recreation. Nor is this all the good for which they are responsible. There is no doubt that the engaging together in various sports and pastimes does much to further and to foster what may be called a "community spirit" among those who work in the same business and the same plant. It tends to good-fellowship and a spirit of genuine goodwill. Further, it undoubtedly encourages a highly desirable "esprit de corps" among the workers in their relation to the organization by which they are employed—as, indeed, does everything which beneficially emphasizes the human equation in the individual worker.

The Stove Plant At St. Laurent.

The Montreal plant of the Gurney Foundry Company, Ltd., is located, as has been indicated above, at St. Laurent. Happy are the workers whose lot is cast in so pleasant a place. For St. Laurent is a little town of great natural beauty easily accessible to Montreal from which it is distant only three miles by way of the tunnel and not more than five or six miles journey by way of trolley car or cement road. It is situated immediately back of the Montreal mountain, and the surroundings of the plant give splendid conditions for the workers. As the Company only acquired this addition to its organization last year, there has not, so far, been any systematized gathering together of recreational activities. But, no doubt, this will come ere long. In the meantime, the employees are to be congratulated on the location of the plant. From the point of view of living conditions, the location is everything that can be desired—close to a big city and yet with the advantages of country life.

Further, for suitability to the type of work which is done at the plant its location coud not easily be improved. Shipping facilities generally are admirable. In particular, the siding facilities are all that could be desired, comprising, as they do, about a quarter of a mile of siding for loading and unloading. In connection with the manufacture of stoves, it is of great importance that there should be plenty of storage room. In this respect, the St. Laurent plant of the Gurney Foundry Company, Ltd., is well provided. For the warehouse accommodation, is thoroughly adequate, and this renders possible the storing of stoves for the fall business.

Description of the St. Laurent Plant.

As in the case with the Company's boiler and radiator plant at West Toronto, there is no lack of space about the stove plant at St. Laurent. The site on which it stands covers approximately 18 acres of which the buildings (some of which are one story and others two, three and four story) cover approximately 3½ acres. The moulding shop is elaborately equipped for the production of light castings by machine, and the press department is a model of its type for the production of stampings of all gauges used in Gurney stoves.

The cleaning, nickeling and assembling departments are extensive and have been so designed as to give a maximum of light to the worker. These departments are all very completely equipped for their respective purposes.

A recent development of the stove business has been the introduction of vitreous enamel which is really glass fused into the surface of steel. Any color may be produced and as the finish is absolutely not affected by heat and may be cleaned as readily as any cooking utensil, it has become very popular. Further, the introduction of color in this finish has made it possible to lend added attractiveness to a modern kitchen range—an attractiveness little dreamed of in days gone by. This vitreous enamel department occupies a separate building.

In addition to producing enamel for Gurney Stoves, the production of signs where a lasting result is desirable, has becomean extensive department of this business.

Almost No Limit To Its Expansion.

As was pointed out just now, despite the very general character of the period of business depression through which we are passing—one is almost inclined, in view of certain signs of improvement, to say through which which we have passed—it has been the experience of the Gurney Foundry Company, Ltd., that business has steadily, if slowly, been picking up since the beginning of the year. This experience has been none too general among Toronto manufacturers. But the business of the Gurney Foundry Company is not typical of Toronto manufacturers. A very large proportion of the manufacturing in the Queen City is concerned with the making of light and largely non-essential articles. The products of the Gurney Foundry Company certainly do not fall within that category. Whether people are prosperous or otherwise, they must have stoves and furnaces—these things are not luxuries, but necessities. That is why this Company finds business picking up when too many other plants have been constrained to close down. It is partly because the industries of Toronto are less basic than those of Montreal that industrial depression is more acute in the former city. But the Gurney Company is engaged in an industry that is basic. It is firmly rooted in the industrial life of the country, and, with the increase in population which is to be looked for when normal conditions recur, there will be almost no limit to its possible expansion.

SIR ROBERT HADFIELD, FRITZ MEDALIST.

It is doubtless unnecessary to remind American engineers that the John Fritz award was instituted twenty years ago by the American societies of Civil, Mining, Mechanical and Electrical Engineers, and the first medal bestowed upon its namesake on his eightieth birthday. Designed to perpetuate that genial iron master's achievements in technology, particularly mechanical engineering applied to steel manufacture, it has become the most coveted honor at the disposal of American engineers and has been bestowed upon the following eminent scientists and engineers:

Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison, Charles T. Porter, Alfred Nobel, Sir William Henry White, Robert W. Hunt, John Edson Sweet, James Douglas, Elihu Thomson, Henry Marion Howe, J. Waldo Smith, George W. Goethals, Orville Wright.

During the past year it has been the ambition of the board of award to express the obligation which American engineers feel not only for the terrible sacrifices made by the engineers of Great Britain in the war, but for their great engineering achievements for the preservation of civilization. It ultimately found expression in making Sir Robert Hadfield the next John Fritz Medalist, not only for personal achievements, especially the invention of manganese steel, but through him, to his brother-engineers. A deputation of representative Americans, including Ambrose Swasy, Ira N. Hollis, Charles T. Main, F. B. Jewett, Christopher R. Corning, Arthur S. Dwight, John R. Freeman and Charles F. Rand, will bear this message of good cheer to the other side, and present the medal on June 29, during the meeting of the Institution of Civil Engineers of Great Britain, in London. Far from a jealous feeling that such an honor should go beyond our boundaries, nothing but good will and cordiality accompany it and the wish that the problems of reconstruction may be as effectively surmounted as those of the great war!

Sir Robert Hadfield, although born in Sheffield, Yorkshire in the year 1859, comes from the Derbyshire family of that name who live at Edale. This quaint Derbyshire village is surrounded by the Kinderscout Hills, almost mountains, from 1,800 to 2,000 ft. in height. It is the center described both by Mrs. Humphry Ward in "David Grieve," and Charlotte Brontë in her novel "Jane Eyre." Edale is not far from historic Castleton, celebrated by Sir Walter Scott in his "Peveril of the Peak," with its Mam Tor, Win Hill, the Shivering Mountain, the famous Blue John mine and other fascinating places of historic interest. Chatsworth, Haddon Hall and Rowsley are all within hailing distance, and through these Derbyshire vales flows the well-known River Derwent of Isaak Walton fame.

Young Hadfield was educated at Sheffield Collegiate School, where he obtained in 1874 two scholarships and prizes in natural science. In 1876 he entered the laboratory of his father's works, and at the age of twenty-three discovered the remarkable properties of manganese steel. Another very important invention—low hysteresis steel, which is also saving the electrical trades many millions of dollars annually—was made a few years later. More recent research has been particularly successful in the line of development of heavy armor-piercing projectiles, and light body armor. In 1888 he became chairman and managing director of Hadfields, Ltd., which post he has continuously held. Despite the demands upon a busy executive, he has never lost his keen interest in fundamental metallurgical research. In fact, his important contributions to scientific literature number 128 in all, and cover, often in encyclopaedic manner, such subjects as manganese and alloy steels, sound ingots, corrosion, research, physical testing, microscopic and X-ray examinations, ancient and modern metallurgical history, shorthand (Sir Robert makes free use of this method in handling his voluminous correspondence), patents, and the labor question. That his interest in the latter is not entirely academic may be inferred from the fact that he introduced the forty-eight-hour week at the Hadfield works in 1891.

His honorary membership and fellowships, awards, presidencies, vice-presidencies and degrees are far too numerous to catalog. Among the most notable might be mentioned Master Cutler of Sheffield, 1899-1900; president of the Iron and Steel Institute, 1905-1907; president of the Faraday Society, 1914-1920; Bessemer Medalist and special gold medal from Societe d'Encouragement pour l'Industrie Nationale. He received special letters of thanks from the Prime Minister and the French Ambassador for services rendered to the nation during the war, in connection with the Hadfield Hospital at Wimereux, near Boulogne, and for which he was entirely responsible from November, 1914, to January, 1919; during this time no less than 16,300 cases were dealt with; also from the Minister of Munitions (Winston S. Churchill) for services rendered as a member of the advisory panel of the Munitions Inventions Department.—"Chemical and Metallurgical Engineering."

NEW PURCHASING AGENT FOR ALGOMA STEEL CORPORATION.

The Algoma Steel Corporation announces the appointment of S. V. McLeod as purchasing agent, with headquarters at Sault Ste. Marie, Ont. Mr. McLeod succeeds L. L. Jacobs, who has resigned.

PRODUCTION OF DOMINION STEEL CORPORATION.

The main items of the output of the Dominion Steel Corporation during the first half of 1921 were as follows:

	Jan.	Feb.	March	April	May	June
Coal (g. t.)	294,723	269,800	231,666	207,492	303,535	325,000
Coke (n. t.)	14,151	12,730	14,080	13,416	13,626	18,768
Ore (g. t.)	23,615	28,972	34,844	36,655	37,866	37,324
Rails (g. t.)	......	......	......	......	......	6,695
Pig iron (g. t.)	9,668	8,100	9,442	8,865	9,602	12,121
Ingots (g. t.)	14,112	11,099	12,181	7,667	3,444	12,125
Blooms	9,898	7,879	10,266	8,833	4,678	9,801
Billets	6,006	5,584	9,129	7,733	2,778	782
Rods	1,650	2,391	2,734	2,115	958	1,943
Wire	1,418	1,104	1,695	1,151	718	828
Nails	1,502	861	1,084	757	324	68
Sulphate, lbs.	618,240	546,560	613,760	600,320	568,960	797,440

STATEMENT BY PRESIDENT OF BETHLEHEM STEEL COMPANY ON REDUCED STEEL PRICES.

E. G. Grace, President of the Bethlehem Company, authorizes the following statement:

The Bethlehem Steel Company announces a new schedule of steel prices, effective Tuesday, July 5th. The changes are as follows:

	Old Prices.	New Prices
Bars	2·10	1·90
Structural Shapes	2·20	2·00
Plates	2·00	2·00
Sheet Bar	39·00	35·00
Billets, 4 by 4	37·00	33·00
Slabs	38·00	34·00
Blue annealed sheets	2·85	2·65
Black sheets	3·75	3·50
Galvanized sheets	4·75	4·50
Tin Plate	6·25	5·75
Skelp	2·20	2·00

The new prices represent a reduction of $4 per ton on bars, structural shapes, plates, skelp, billets, sheet bar, slabs and blue annealed sheets; $5 per ton on black and galvanized sheets, $10 per ton on tin plate.

Present manufacturing costs do not in any sense warrant these reductions, but this Company desires to contribute even more than its full share to re-establish conditions in the steel trade on what might be regarded as a normal basis.

There has been so much said about steel prices not having been reduced to pre-war levels that an analysis of the new prices is desirable and will be illuminating to both the trade and the general public.

The increase in freight rates has been the largest factor in increasing the cost of manufacturing steel products because the making of a ton of finished steel involves the transportation of more than 5 tons of raw materials. The cost factors next in importance are materials and labor.

Taking as an example the price for structural shapes, under the new schedule of prices, 2 cents a pound or $44·80 a gross ton, the comparison with pre-war prices, reflecting concretely the three more important cost factors is as follows:

1. The increase over pre-war cost in transportation on ore, coal, limestone, scrap and miscellaneous supplies amounts to $7·85 per ton of finished steel.

2. The increase in the cost of coal, ore, limestone, alloys, refractories, lubricants, and miscellaneous supplies at point of shipment amounts to $7·10 per ton of finished steel.

3. The increase in the cost of labor under the present wage scale, as compared with pre-war wages, in the steel plant proper, is $5·64 per ton of finished steel.

These items account for an increase in present day costs over pre-war costs of $20·59 per ton of finished product. The new price of $44·80 for structural steel is equivalent to a pre-war price of $24·21 per ton, or 1·08 cents per pound.

Statistics covering the last twenty years show in only one month (December, 1914) has structural material been sold as low as this figure (1·08 cents). The ten-year pre-war average (1904-1913) was 1·51 cents per pound.

The figures I have used are the results of actual compilation made by the Company's comptroller in the every day conduct of the business.

NEW YORK OPINION ON STEEL TRADE PROSPECTS.

Boston News Bureau, under date July 11th, states that New York steel trade opinion is that Bethlehem Steel's announcing new price schedule conforming to actual market for some weeks, will go a long way towards stabilizing the situation. Bethlehem's list has been adopted by the entire trade.

Feeling also appears to be that prices now ruling represent the approximate minimum until other factors outside the steel trade are adjusted downward. These are principally general living costs, construction costs and freights.

It is doubtful if any concern, outside of the Steel Corporation, can show an operating profit at current levels, and even the corporation can show only a small margin.

Steel wages have been deflated more than generally recognized, far more than in construction, railroad and other industries. From a high point of 46 cents an hour, with time and a half for overtime, steel common labor will, when new wage adjustments are made, receive from 27 cents an hour at Bethlehem plants to probably 30 cents at other independent plants, with no overtime. That all independents will adjust wages before July 15 is certain. With an average wage of around 30 cents an hour at independent plants, steel wages will be only 50% above pre-war level and it is

not thought further wage cuts, while cost of living remains at present levels, would be either fair or wise.

Steel prices have been deflated to a point practically as low as early in 1913. Bars, selling at $42.56 a gross ton in spring of that year, are now quoted by independents at $44.80. The low for bars since beginning of the century has been $24.19 and, as pointed out by Pres. Grace of Bethlehem, costs have advanced over $20 a ton. Allowing for the increase in cost, steel makers are about as well fixed regarding profit margin —or lack of profit margin—now as in the worst prewar period. Compared with the best pre-war price, their profit margin is over $18 a ton smaller.

Opinion in the trade is that revised price schedules will help to stimulate buying, although it is not believed new demand can be expected in any volume for a month or two. The trade is looking for improvement to start before the end of August and to accumulate volume steadily thereafter.

BOOK REVIEW.

FOUNDRYWORK. Shaw & Edgar, Isaac Pitman & Sons, Toronto, 115 pp. with index. Price $1.00.

This is one of Pitman's technical primer series, and is a companion volume to the primer on patternmaking, by the same authors. It deals with iron and brass founding, and endeavours to give the main principles which are involved in general foundry practice for the information of engineers, draughtsmen, apprentices and students. The book deals concisely with the history of founding, shrinkage and contraction, materials and tools, green-sand, dry-sand and loam moulding; with cast-iron and steel castings, and with appliances for melting metals previous to pouring. While dealing chiefly with English and Scotch practice, as regards materials referred to, it is a useful introduction to more comprehensive treatises on foundry work, which is in agreement with the intention and scope of this series of handy and well-printed primers.

THE OPEN HEARTH. Its Relation to the Steel Industry. Its Design and Operation. Victor Windett, and associate engineers of the Wellman-Seaver-Morgan Company. 8½ by 11 by 1 inches. U. P. C. Book Co., 243-249 West 39th St. New York.

The purpose of this handsome volume, which is dedicated to Samuel T. Wellman, father of the open-hearth in America and founder of the Wellman-Seaver-Morgan Company, is, as stated in the preface, to gather into one volume authentic engineering data relative to the construction, design and operation of open-hearth furnaces, and the machinery and accessories used in connection with these furnaces. The data is of course, largely extracted from the records of the Wellman-Seaver-Morgan Company. As the work treats of the whole theory and practice of open-hearth work, it is not useful to attempt any summary of its scope, beyond this statement. There is very much valuable historical and chronological information in the work, and in addition to large-scale photographs, there is included a very large number of reproductions of blueprint working drawings. At the end of the book there is shown some of the more notable coal-handling and transportation machinery in which the Wellman-Seaver-Morgan Company has excelled. The work, apart from its other commendable features, is interesting as a pictorial record of the variety and magnitude of the machinery used in the steel and coal industries in the United States.

FOUNDRY MOULDING MACHINES AND PATTERN EQUIPMENT. Edwin S. Carman, 225 pp. 6 ins. by 9 ins. cloth, with index. Price $5.00. Penton Publishing Co., Cleveland, Ohio.

Mr. Carman is president of the American Society of Mechanical Engineers, and has taken a large part in developing the moulding machine, having designed a number of machines himself. The book is expressly written to answer the question of the practical foundryman, "Will it be profitable to run this on a moulding machine, and if so, on what type of machine?" Mr. Carman points out that machine moulding does not dispense with the skill of the moulder but rather enables him to develop the niceties of his draft by relieving him of heavy weight-lifting and laborious ramming, of such a routine repetitive character as to allow the substitution of the machine for muscle. The illustrations are numerous and as applied to a series of machine-moulding operations, showing the successive stages, are a great aid to the text. A large number of typical castings are shown in fully drawn detail, comparing actual performances in casting, without machines, and with specified types of machines. The number of men employed, hours worked, and quantity of moulds are given, and the percentage of increased production by use of machines is given. In all cases it is most striking, and is of course particularly so where a large number of castings of identical shape are required, as in automobile manufacture and railway castings. The book is in its second edition, and is very recently published in enlarged form. It is a practical description of modern machine-moulding, and is based on first hand knowledge and earnest belief in the future of this development of foundry practice, by one who has had much to do with that development.

NOVA SCOTIA STEEL AND COAL CO'S PRODUCTION.

During the first half of 1921 the steel plant at Sydney Mines has not operated. Coal totalling 280,825 tons was produced during the six months ending June 30th, and 99,121 tons of iron-ore, of which a proportion was sold for overseas delivery. At the Trenton plant during June, 884 tons of bars of various sizes and 124 tons of rivets, pit-spikes, and bolts and nuts were made. During June 61,300 tons of coal and 23,050 tons of iron ore were mined.

DEATH OF W. W. WYLIE, OF OTTAWA CAR MANUFACTURING COMPANY.

William Washington Wylie, head of the Ottawa Car Manufacturing Company, died at Ottawa on June 24th as the result of a paralytic stroke. Mr. Wylie, who was born in Chile, came to Canada about 40 years ago, and has been in charge of the Ottawa Car enterprise for nearly 25 years, it having been commenced as the W. W. Wylie Carriage Works. The result of Mr. Wylie's hard work and capabilities is seen in the extent to which the works have grown.

Advances in Metallurgy During The War

(Abstracted from the Presidential Address Before the
the Institution of Mining and Metallurgy.)

By F. W. HARBORD.

The technical advances in different branches of metallurgy during the war have already been dealt with in the addresses of past Presidents, and Mr. Picard in his able address two years ago very fully described the progress made during the war period. I do not purpose to refer in detail to the improvements which have been made, except in a few special cases in that branch of metallurgy with which I have been most closely associated, but rather to consider the general effects of the war on our metallurgical and kindred industries. Two years and a half have now elapsed since the signing of the armistice, and it is still extremely difficult under the prevailing unsettled conditions to review the effects of the war in their true perspective, but a careful examination of certain facts may enable us provisionally to take stock of our present position.

The losses caused by the war, both directly and indirectly, to all branches of industry, are too well known to need comment, but the influence of the war on the development of new industries, and effect it has had on the capacity for production in such industries as were well established before the war may not be so generally known.

With the exception of **tungsten powder** and **ferro-alloys** generally, so far as I am aware, no strictly metallurgical industries were established as the result of war requirements. Tungsten powder, as is well known, was not made in this country previous to the war, and although ferro-tungsten alloys were made to a small extent, it was only our war requirements which led to the development of these industries on such a scale as to enable us to supply the chief markets of the world. We are now also in a position to produce far more ferro-chrome, ferro-molybdenum, and other ferro alloys, with the possible exception of ferro-silicon, than are required for home cousumption. The plants available in this country are probably sufficient to enable us to produce the last, but the large amount of power consumed, combined with the relatively low price of the alloy, makes it impossible for us to compete with countries like Norway and Sweden which possess the advantage of cheap water power. Ferro-chrome, owing to its relatively higher selling price, is in a better position, especially in cases where power can be produced from coke or blast furnace gases.

At the time of the armistice most of our steel works either had stocks of **ferro-chrome** and other **ferro alloys,** or had bought forward, and the sudden cessation of all demand caused great dislocation in this new industry, from which it has not, up to the present, recovered. Works which were specially built for the manufacture of alloys have either had to suspend operations, or to modify their furnaces and utilize their power for the production of steel or other products. It may be anticipated that when chrome ore can be shipped to this country as a reasonable price, and trade generally improves, this new industry will be able to hold its own.

Early in the war, owing to the difficulty of obtaining **carbon electrodes,** plants were erected for manufacturing them in this country, and we are now able to more than meet the home demand. The expenditure on electrodes in all electric furnace operations is a very considerable item, and any reduction in the costs of manufacturing these is of special importance. In this connection the Solderberg self-baking electrode, which dispenses with the cost of baking the electrodes previous to use, and does this in situ during the operation of the furnace, offers distinct possibilities. It was recently introduced in Norway, and is stated to be giving satisfactory results, and should be these be confirmed, the cost of electrodes per ton of alloy produced will be appreciably decreased. It is also of interest to record that graphite electrodes used in some steel furnaces, and largely in the chemical trades, for which we have had in the past to rely entirely upon imports from America, are now being made satisfactorily on a commercial scale in this country, although it is too early at present to say if they can be produced at a sufficiently low cost to compete with those imported.

During the war there was a great demand for **ferro-vanadium,** but owing to our being unable to obtain supplies of raw material, it was impossible to manufacture this alloy in this country, and we had to depend entirely upon America for our supplies. It is estimated that 96 per cent of the world's output of vanadium ores is obtained from the Peruvian deposits which are controlled by the Vanadium Corporation of America, and the remainder is largely supplied from the Colorado deposits, now also controlled by the same American company. The vanadium lead properties at Doornhoek in the Zeerust district of South Africa have been recently opened up, but are not yet sufficiently developed to enable a definite opinion to be expressed as to their future possibilities.

The extended use of **vanadium** for the manufacture of special steels for the automobile and other industries, and the possibility that there will in the future be a demand for cupro-vanadium and other non-ferrous alloys containing vanadium, make it a matter of considerable importance that other vanadium deposits should be sought for, especially within the Empire; this is a matter which is well worth the serious attention of our mining engineers and geologists, particularly those engaged in prospecting in different parts of the world. A recent development in connection with the metallurgy of ferro-vanadium is the direct reduction by carbon in the electric furnace which may possibly appreciably reduce the cost of production.

Ferro-molybdenum has so far not been largely used either to alloy with structural steels, or with medium carbon steels, or to replace tungsten in high speed steels, and so long as ferro-tungsten can be obtained at anything like the present prices, ferro-molybdenum is not likely to be used in the manufacture of high speed steels. It is, however, being used to some extent in the manufacture of steels for automobile parts, and it is possible its use in this and some other directions, such as for armour plates and other steel needed for war purposes, may be considerably extended in the future.

Small quantities of **ferro-uranium** and **ferro-zirconium** have been made for experimental purposes, but the

effect of either uranium or zirconium on the physical properties of alloy steels has not been fully investigated.

Early in 1915, the great demand for all classes of steel for munition purposes necessitated special steps being taken to increase production, and as a result the capacity of our iron and steel plants has been increased to greater extent than that of the plants of any of our other established metallurgical industries. In the year 1912, our total pig iron production including alloys was only 8,750,000 tons, and in 1913 this increased to 10,-260,000, which was the largest output ever obtained. During the first two years of the war this dropped until our total production was only 8,790,000 practically the 1912 figure. This decrease, however, was largely due to a smaller production of foundry iron, although there was some falling off in the production of pig iron for steel manufacture. The seriousness of the position was soon realized, and every effort was at once made to increase production, with the result that in 1916 the output was greatly improved, and still further increased in 1917. At first the increase was practically due to a larger production of hematite pig iron made principally from imported ore, but as the shipping difficulties became greater, we had more and more to rely upon basic pig iron produced from home ores, and in 1918 we made nearly half a million more tons of basic pig iron from these ores, than had been produced in 1913, the year of the maximum production, and nearly a million tons more than in 1914. To meet these requirements, the home ore production was increased during 1916-17 by over 1,500,000 tons, largely owing to the untiring efforts of my predecessor, Mr. Merricks. The use of basic pig iron instead of hematite, and the increased demand for steel, necessitated converting acid lined steel furnaces into basic lined furnaces, and in some cases erecting entirely new steel plants. By the end of 1917 the total production of steel had increased by over 2,000,000 tons as compared with the output of 1913, of which over 1,000,000 tons was basic steel. In the years 1916-18 arrangements were made for the erection of 22 blast furnaces, and 166 open hearth steel furnaces with a producing capacity of over 3,000,000 tons of steel per annum. In some cases additions were made to existing plants, and in other cases entirely new plants were built.

The new works were equipped with the most modern improvements and labour-saving appliances, and were erected in different parts of the country; some are now in full operation, and others are either in partial operation, or ready to commence as soon as the conditions of the trade justify it. One noticeable feature was the large number of electric steel furnaces which were erected during the war period to produce the special steels so urgently required for war purposes, and although at present a number of these furnaces are standing idle it is to be hoped that this is only a passing phase, and that they will soon be in full operation again. During the war these furnaces were very largely used for the manufacture of alloy steels, although the manufacture of such steels was by no means confined to them, large quantities being made in the ordinary open hearth furnaces.

Probably no branch of metallurgy received a greater stimulus, and in no branch has greater progess been made than in the art of heat treating special steels, to meet the many and varied requirements of the war. Apart from the large demand for automobiles, the developments of our air service necessitated the production of large quantities of steel possessing very special qualities, high maximum stress, and high elastic limit, combined with considerable ductility, toughness, and above all things reliability. Steel parts of lightest possible section had to be used to keep down the weight, some of these were subjected to tension, some to compression, some to alternation of tension and compression, and some to shear and bending stress; others, again, were subjected to shock and some had to resist abrasion and erosion.

Most of these alloys were nickel or nickel chrome steels, and some contained small percentages of vanadium, but it was not so much in the composition of steels that progress was made, as in the detailed and systematic heat treatment. Most of these alloy steels are extremely sensitive to heat treatment, and any appreciable variation either in chemical composition or in the temperature of quenching or tempering, has a marked effect on the physical properties of the material. It is comparatively easy in experimental work in the laboratory to control heat treatment with pyrometers, but when it becomes necessary to manufacture thouands of tons of material under conditions in which pyrometric control within narrow limits is essential, the difficulties can hardly be exaggerated.

These difficulties were greatly increased by the pressure under which all work had to be carried on, and so great was the demand that those steel makers who had had special experience in the manufacture and heat treatment of these steels were unable to meet it, and many steel makers with little experience in his class of work had to undertake the manufacture. Specifications for steels for the various purposes were prepared by the Air Board, giving detailed directions as to heat treatment, etc., and the quality of the resulting material was systematically controlled by analyses and by very complete mechanical and physical tests, carried out under the supervision of a special technical staff. In a comparatively short time manufacturers by great attention to detail were able to produce satisfactory material.

The supply of a suitable steel for valves for aeroplanes was a somewhat difficult problem, as this steel has to be mechanically strong at all temperatures varying from 100° to, in some cases, above 850° C., must be capable of resisting shock, abrasion, and erosion, and must not harden when air-cooled from the maximum temperature attained under normal working conditions. Further, the steel must resist oxidation to the maximum extent, be easily heat treated without developing cracks, forge readily, and have good machining properties. The steel most largely used for this purpose were high speed tungsten steel, high chromium steel known as 'stainless' steel, and 3 per cent nickel steels containing varying percentages of carbon. The high speed tungsten steel containing about 12 per cent to 14 per cent of tungsten is one of the best known high speed tool steels, and the stainless steel, containing from 11 per cent to 15 per cent of chromium is well known by its being so largely used for cutlery.

The experience gained in this branch of steel manufacture cannot fail to have very important results in improving the quality and reliability of steels used for various purposes, more especially those employed in the manufacture of automobiles, and it is to be hoped that some of these special steels may find applications in our mining and metallurgical industries, where great

strength, combined with lightness is required, or resistance to corrosion or erosion is essential.

For many years before the war our **zinc** industry was in a languishing condition, but here again the productive capacity of the country has been greatly increased, not only by the erection of the new plant at Avonmouth, but by extensions and improvements to existing works.

Owing partly to the high freights prevailing during the war and since the armistice, and to the difficulty of obtaining zinc ores from Australia due to the stoppage of the Broken Hill mines, it became almost impossible to obtain supplies, and for many months after the armistice the spelter works in this country had to be rationed in respect of their ore supplies, while all of them were working only part time, with consequent greatly increased working costs. In addition to this they had to contend with the great rise in price of fuel, and later a rapid fall in the selling price of smelter, owing to the large stocks which had accumulated during the war in America, and which in some cases were sold at prices many pounds per ton below the cost of production.

Within the last few months spelter has been sold under £24 per ton, and it is estimated that the cost of production is not less than £35 per ton, even under the best conditions, and on an average not much less than £40. Under these conditions our spelter manufacturers have had to close down their works, and I greatly regret to say that at present there are no spelter works operating in this country to their full capacity, and only one or two producing to a very limited extent.

The present position of the industry is, however, quite abnormal, and within a reasonable time we may be certain that the commercial conditions will so adjust themselves that with the reduction in freights, and the end of the strike at Broken Hill, we may again expect to see our spelter works commencing to operate.

When the relation between the cost of production and the market price of spelter becomes normal we shall have two very strong points in our favour: firstly, our works are better equipped than they ever were before; secondly, our Government has the control of all the Broken Hill zinc ore supplies upon which the continental zinc smelters so largely depended before the war, as practically the whole output was then shipped to Germany and Belgium. This control of raw material should have a very important bearing on the future of spelter production in this country, and provided that we can obtain fuel at a reasonable price we ought to be able to rehabilitate the industry.

In a paper recently read before this Institution, Mr. Gilbert Rigg called attention to the advance made in the roasting of zinc ores by the blast roasting process. The latest information to hand confirms the opinion he then expressed that this method of roasting may have an important influence on the future of the distillation process, not only because it reduces the roasting costs, but largely owing to the better physical conditions of the roasted product, which is more readily reduced in the retort thus reducing the fuel consumption and increasing the yield of spelter.

The recent improvements in the **electric deposition of zinc** and in the electro-thermic process may materially affect the future of the zinc industry. In Tasmania results obtained with an experimental plant producing 10 tons of electro deposited zinc per day were so successful that a larger plant was installed, and more recently a company has been organized to erect a plant to produce 30,000 tons of spelter per annum based on the results obtained with these plants.

Considerable improvements have also been made in the **electro-thermic process**, and a new plant to produce spelter on a large scale is being erected in Norway. Both this and the electrolytic processes depend for their ultimate success primarily upon the cheap production of electric energy, and the commercial production of spelter by these processes is only possible under conditions when electric energy can be be produced at a relatively low cost. The details of the technical improvements which have brought both these processes again into prominence are not yet available for publication, and it will be some time before commercial value can be fully determined, but both processes undoubtedly possess possibilities which may ultimately make them very powerful competitors with the distillation process.

Although the production of **coke** cannot be strictly considered a metallurgical operation, its economic production has such an important bearing on most of our metallurgical operations, that the influence of the war as affecting it merits careful consideration. In 1914 our production of metallurgical coke was just over 10,000,000 tons per annum, and in 1916 the shortage was so serious that an urgent appeal was made to all coke manufacturers to increase their output. This met with a ready response, and by increasing the temperature and so reducing the coking time, our manufacturers increased the output per oven by 17 per cent., and their total production by 1,285,000 tons per annum as compared with the 1915 output. In addition to this, 800 old beehive ovens were repaired and put into operation, and by the end of 1917 the total annual output had increased by 2,750,000 tons as compared with that of 1914. This increase required more than 4,000,000 additional tons of coal per annum, and notwithstanding the shortage of labour due to recruiting, our miners rose to the occasion.

The low yield of coke in the beehive oven as compared with that of the by-product recovery oven, involving a serious loss of coal and all the by-products, made it imperative to replace the former by by-product recovery ovens at the earliest possible moment, and during the war more than 1,750 by-product coke ovens were erected, capable of producing approximately 4,500,000 tons of coke per annum.

At the end of the war we were producing 80 per cent. of our coke in by-product ovens as compared with 58 per cent. pre-war, which, in addition to the recovery of all the by-products, effected a saving of approximately 800,000 tons of coal per annum.

One of the great difficulties in connection with our coke oven plants was the supply of suitable bricks for the walls of the by-product ovens. Previous to the war our coke oven builders used bricks imported almost exclusively from Belgium or Germany, and for a time considerable difficulty was experienced in obtaining suitable bricks in this country, as the ordinary firebrick contracted too much By increasing the percentage of silica in the bricks and by careful attention to manufacturing details, our leading brick makers soon succeeded in producing a satisfactory brick. I was recently informed by a Director of one of the large by-product coke oven companies, that bricks quite equal to those previously obtained from the continent were now being produced in this country in sufficient quantity to meet all requirements.

Another class of refractories which gave rise to seri-

ous anxiety was **magnesite bricks**, which were essential for the maintenance of the full output from our basic open hearth steel furnaces. Previous to the war these bricks were all imported from Austria, and our difficulties were increased by having to import all the raw material, there being no deposits of magnesite in this country. Supplies of magnesite from Greece and India were obtained, and arrangements made with the brick makers to instal the necessary plant for burning the magnesite and manufacturing the bricks. Although considerable difficulty was experienced at first in producing a brick of the necessary strength and coherence, these difficulties were gradually overcome, and satisfactory bricks were soon made in sufficient quantity to meet our requirements. To-day the manufacture of these bricks is firmly established.

Under existing conditions there is nothing more vital to the industrial existence of the country than the utilization of all classes of fuel, and in this connection recent development in coal washing by what is known as 'froth flotation' may have important results, especially in dealing with coal in which the mineral matter is so intimately associated that it is not separated by the ordinary methods of washing depending upon gravity. To obtain satisfactory results, this, like all flotation processes necessitates fine grinding, but apart from the small extra expense this is no serious drawback when the washed product is to be used for coking purposes, or briquetting; in the case of most coals fine grinding will almost certainly appreciably improve the quality of the coke. At present the process is only just emerging out of the experimental stage, but with certain coals very promising results have been obtained, and its future development offers considerable possibilities.

Pulverized fuel is now being used direct in various metallurgical operations in the United States and to some extent in this country, and under certain conditions its use is both efficient and economical. The cost of grinding and the difficulty of storage, etc., are disadvantages, but the complete gasification and combustion of solid carbon at the point where the maximum heat is required is theoretically sound, and when there is no metallurgical or practical objection to its use, the greater efficiency obtained may more than balance the above disadvantages. Another possible development in this connection is the use of colloidal fuel, which at present is being tried experimentally for various purposes, and the results will be awaited with the greatest interest.

Indirectly connected with the question of fuel economy is that of the cleaning of the blast furnace and other gases which are to be used for preheating the blast, steam raising, and other purposes.

Until comparatively recently, except where the gas has been required for use in internal combustion engines, the appliances for the removal of dust from furnace gases have usually been of a very primitive character, consisting generally of nothing more than a large settling chamber to catch the coarser particles of dust.

Metallurgical engineers have not fully realized in the past the great loss incurred, both directly in efficiency and indirectly in cost of repairs and renewals, by the use of dirty gas, whether in the regenerative stoves or for steam raising purposes, but gradually the saving to be effected by efficient gas cleaning is being realized. Various methods of washing the gas by water sprays have been tried, but the installations are very costly and these wet methods have other disadvantages.

The electrostatic method of gas cleaning, both on the Cottrell and Lodge system, is now in operation in various works in America and this country. It is in use both for removing dust from gases required for heating purposes and also for the recovery of finely suspended matter, such as zinc oxide, lead oxide, potash salts or other valuable products, with in many cases satisfactory results. The initial outlay is, however, heavy, and when the gas is to be utilized for direct heating only, it is a question whether the capital cost is justified.

The Halberger-Beth system of gas cleaning, by which the gases are first cooled by air or water to about 175° F., and afterwards drawn by suction through special canvas bags, has been adopted at some works, and the removal of the dust is said to be very complete, sufficient to enable the gas to be used in gas engines. Here again the capital cost of the plant is very high, and the removal of the dust is more complete than is necessary when the gas is only required for direct combustion for steam raising or other purposes.

A method of gas dry cleaning known as the Kling Weidlin method has recently been introduced in the United States; several plants are operating there, and some two or three are now being erected at different works in this country. This process does not claim to remove the dust from the gas to the degree required for gas engines, but to reduce it to the limits necessary for ordinary combustion purposes. It consists of filtering the gas through a fine iron or steel wool mattress; at regular intervals the mattress is rapidly agitated for a few minutes to remove the dust, the gas during this period being automatically by-passed through another filter. So far as can be judged by the results obtained up to date, this is giving satisfactory result for blast furnace gases. Whether this method would be applicable to the problem of recovering valuable products in suspension in the gases would depend largely upon the nature of the dust, and so far as I am aware it has not been tried for this purpose; it obviously could not be used when the gas would act chemically on the fine steel wool mattress.

RE-HEATING FURNACE FOR DOMINION STEEL RAIL-MILL.

The newspapers recently attributed to the heads of the Dominion Steel Company a statement that a new process of rail manufacture had been developed at Sydney, a report that probably originated in a misunderstanding regarding the new re-heating furnace which is being installed between the blooming and the rail mills at the Sydney Plant. This furnace, which is to be of large capacity and of modern continuous gas-fired type, will replace a smaller and rather old-fashioned re-heating furnace. The new furnace will have a sufficiently large capacity to hold sufficient blooms from the night turn to keep the rail-mill operating at full capacity all the dayturn and will thus obviate the night-shift on rail-rolling which has been found necessary with the old re-heating furnace. It is expected also that delays, occurring either in the blooming mill, or the rail-mill, will be much minimised by the additional capacity of the furnace.

This addition to the rail-mill is, of course, in line with standard practice, and is part of a modernisation of the Sydney Plant that has now made much progress.

THE RELATION BETWEEN BACTERIA AND CERTAIN IRON AND MANGANESE ORES.

More than eighty years ago Ehrenberg investigated a certain bog iron-ore and found it to consist of the remains of algae. In this connection it is of interest that a few years ago (or just prior to 1915) Albert Orion Hayes made a microscopic examination of the Wabana haematite of Newfoundland, and found fossil tubules of minute boring algeae in shell fragments, spherules, phosphate nodules and siderite in the ore ("Wabana Iron-ore of Newfoundland," Memoir 78, 1915, Geol. Surv., Dept. Mines, Canada, pp. 28, 74, 75.) Ehrenberg had observed in the marshes near Berlin a substance of a deep ochre-yellow colour passing into red, which on microscopic examination proved to be composed almost entirely of *Gallionella ferruginea*, one of the iron-bacteria, but Ehrenberg himself mistook the organism for a diatom. Many years later Hans Molisch found the remains of iron-bacteria in three bog iron-ores, out of thirty-four iron ores examined by him. Later, the same investigator examined twenty-seven more specimens of ironstone. He published his results in 1910, and in a limonite of the class known as *Raseneisenstein* (meadow ore or bog iron ore), he found, here and there, inside holes, ochre masses made up almost entirely of fragments of the sheaths of *Leptothrix ochracea*, which is said to be by far the most widetly distributed of all iron-bacteria, having been found universally distributed in ferruginous waters in every country throughout the world. David Ellis, of the Royal Technical College, Glasgow, discovered a new species of iron-bacteria near Glasgow: he named it *Spirophyllum ferrugineum*, but he thinks it highly probable that *Spirophyllum*, *Leptothrix* and *Gallionella* may be pleimorphic forms of one and the same organism (*Iron Bacteria*, 1919, p 38). According to Edmund Cecil Harder, *Spirophyllum* is more widely distributed in American iron springs, mine-waters and iron-bearing well-waters than *Leptothrix*. In one locality he found it occurring in a mine-drift, at a depth of 300 feet, in gelatinous masses near openings where iron-bearing waters issued, and associated with *Gallionella* and *Leptothrix*. "It opens the interesting possibility that not only may these be instrumental in the formation of surface bog ores, but they may play a part in the formation of certain underground deposits of limonite, such as those which occur in the Appalachian region." ("Iron-depositing Bacteria and their Geologic Relations," Professional Paper 113, 1919, U. S. Geol. Surv., p. 80.)

Tyrrell, of Glasgow University, is of the opinion that the Clayband ironstone of this country is the bog iron-ore of the Carboniferous period.

Hitherto, no structures — recognisable as the fossilized remains of iron-bacteria — have been discovered in rocks of older date than bog iron-ore. David Ellis recently examined the Frodingham ironstone, which is a ferruginous, fossiliferous limestone, with distinct oolitic structure, of Lower Lias age. The bulk of the ore is a hydrated iron peroxide or limonite. A search for fossils in the ore revealed the presence, not of iron-bacteria, but of an iron-secreting thread fungus. In this connection it may be mentioned that Harder, the American investigator of iron-bacteria, has found that the mycelia of various fungi often become impregnated with, or coated by, ferric hydroxide (op. cit., p. 11). Ellis concludes that the fossil mould of the Frodingham ironstone "had collected the iron on its membrane in precisely the same way as do the iron-bacteria to-day. That is to say, it must have lived in a ferruginous medium, and the iron in it was collected during its lifetime" (op. cit., pp. 171, 172).

Herdsman has sought to prove the organic origin of the sedimentary ores of iron because many of them are highly phosphoric, but although the phosphorus in the ore may be organic in origin, it does not follow that the ore itself has an organic origin. This argument may be carried too far: Cleveland ironstone, which occurs in seams in the Middle Lias, and the structure of which is generally oolitic, carries from 1 to 3 per cent of phosphorus, which seems to point to an organic origin, but the Frodingham ironstone (Lower Lias) of Lincolnshire only has from 0.2 to 0.5 per cent, the Neocomian (Lower Cretaceous) iron-ores of Lincolnshire, and the Northamptonshire and Rutlandshire ironstones (Lower Oolite), carry about 0.5 per cent of phosphorus, and although the "rakes" (ironstone nodules) of Derbyshire (Carboniferous) may range from 0.5 to even 1 per cent, they sometimes only contain 0.1 per cent of phosphorus. The only Bessemer ore in the United Kingdom — the red haematite of the North of England — which occurs as irregular masses in Carboniferous limestone, produced, it is believed, by metasomatism of the limestone through mineralizing solutions, contains as little as 0.013 per cent of phosphorus, yet the irregular pockets of brown haematite occurring in the Carboniferous limestone of the Forest of Dean, Gloucestershire, which presumably are of similar origin, carry as much as 0.65 per cent of phosphorus (Henry Louis: "The Iron-ore Resources of the United Kingdom"—The Iron Resources of the World, vol. II, 623-641). Again, the ferriferous bauxite of County Antrim, North Ireland, which is a lateritic ore, apparently produced by weathering under tropical climatic conditions of portions of basalt which overlies it, is usually very low in phosphorus, yet James Strachan in 1911 said: "These deposits (iron-ore, bauxite, lithomarge, etc.) represent a slow transition from a moist land-surface to true lacustrine conditions, and during the latter period iron-bacteria probably played an important part in the formation of the sediments" ("The Inter-Basaltic Rocks — Iron-ores and Bauxites — of N. E. Ireland," by G. A. J. Cole, Mem. Geol. Surv. Ireland, 1912, p. 12). This conclusion, however, has not met with general support.

The phosphorus of the Wabana (Newfoundland) haematite averages about 0.6 per cent. Hayes found an intimate relationship between the account of shell fragments and the percentage of phosphorus in the ore rocks at Wabana, and he concludes that the organic remains are the principal source of the phosphorus and calcium of the ore (op. cit., p. 40).

It has been shown that the iron-bacteria are by no means the only organisms on which iron collects in abundance. Reference has already been made to thread fungi and algae. Certain algae collect iron in abundance when growing in ferruginous waters, and the property is also characteristic of certain protozoa. According to Herdsman, an iron-ore placed on a shelf became coated with the organism familiarly known as "dry rot" (*Merulius lacrymans*), which assumed a red hue and threw off spores. The assay of the spores showed them to possess the same iron content as the ore itself (Ellis, op. cit., p. 174.

Some of the iron-bacteria will, under certain condi-

tions, take up manganese. It has been shown that *Crenothrix polyspora*, the pest of reservoirs, will take up manganese as readily as iron. The *Crenothrix manganifera* of Jackson is probably not a distinct species, but an example of the effect produced in *C. polyspora* by living in a medium highly charged with assimilable manganese (Ellis, op. cit., p. 63). Molisch has shown that *Leptothrix ochracea* will thrive abundantly on iron-free culture media consisting of distilled water with 1 or 2 per cent of peptone. However, if iron is present, the organism will show better development, and will deposit ferric hydroxide in its sheath, and, if manganese salts are present, it will deposit hydrated manganese oxide in its sheath (Harder, op. cit., p. 78). This may possibly explain the intimate association of iron and manganese ores in certain deposits. Investigations by W. D. Francis show that ferruginous and manganiferous material in bogs and streams at Kin Kin, Queensland, is composed very extensively, if not entirely, of micro-organic material, chiefly bacterial. A few algae, and, less frequenty, protozoa, are also present ("The Origin of Iron and Manganese Ore in Bogs and Streams," Proc. Roy. Soc. of Queensland, 1916, 28, 80). In this connection, it is interesting to note that Dana, in his "System of Mineralogy", mentions that at Glendre, in the County of Clare, Ireland, a layer of rhodochrosite, two inches thick, occurs below a bog and has a yellowish-grey colour. It appears possible that certain stratified beds of manganese carbonate (rhodochrosite) have been at least partially formed by iron-bacteria, e.g. the manganese carbonate beds of the Cambrian (Ordovician) formation of Merionetshire, North Wales, and beds of the same mineral in rocks of very similar age at Las Cabesses, Pyrenees, France, at Chevron, Belgium, and in Canada, Newfoundland, Arkansas, and other countries.

It must be admitted, however, that our present knowledge is somewhat meagre, and that it is not possible to come to definite conclusions as to the exact extent to which organisms have taken part in the building up of ferruginous and manganiferous ores. All that can be said at present is that iron bacteria are responsible for the formation of ferruginous and manganiferous sediments, which probably form themselves by slow degrees into iron and manganese ores.

CHEAP FUEL THE BASIS OF METALLURGY.

The success of our metallurgical industries and in fact all industries is based on cheap fuel, and unless we produce coal at a lower cost and use it with the utmost economy, it will be impossible for us to export our products at a price at which they can be sold in open competition. In the steel industry, in the production of rail sections, plates, etc., the consumption of fuel per ton of finished steel rolled averages approximately 3 tons of coal, and if we include all the smaller products such as sheets, tinplates, small sections of special steels, wire, etc., etc., the average consumption over the whole industry is very much greater.

In the production of spelter the average consumption is approximately 5 tons of coal per ton of spelter. —F. W. Harbord, before the Inst. of Min. & Metal.

IRON, STEEL AND STEEL ALLOYS UNDER NEW UNITED STATES TARIFF LAW.

Iron and steel are included in the duty schedule of the Fordney tariff bill, but so also are alloys for making steel. Beams, girders and structural iron or steel are tariffed at 25% ad valorem, compared with 10% in the present law.

Railway splice bars ¼-cent pound; other railway bars of iron or steel, and railway bars made in part of steel, rails and punch flat rails 7-40ths of one cent a pound. Axles and forgings six tenths of a cent a pound. If fitted in the wheels they pay the same duty as the wheels, one cent a pound.

Cast iron pipe is 10% ad valorem. If seamed or jointed ¾ to 1¾ cents a pound, according to thickness and diameter. Cut nails above two inches in length four-tenths of a cent a pound; less than two inches 20% ad valorem; horseshoe nails and small nails two cents a pound. Rivets and studs, including those for automobile tires, 25% ad valorem.

Steel ingots, blooms, slabs, billets and bars are taxed by pound according to value, running from two-tenths of a cent per pound when valued at not over one cent a pound to six cents a pound when valued at 32 to 40 cents. Above 40 cents the duty is 20% ad valorem, and circular saw plates pay an additional quarter cent a pound.

Steel in any form or of any process, containing more than 0·6 % of nickel, cobalt, vanadium, chromium, tungsten, molybdenum or other alloy, pays an additional 15% ad valorem. Manganese and silicon are not to be considered as alloys unless in excess of 1%, and 72 cents per pound on the tungsten content in excess of 1% shall also be levied.

Plates, excepting crucible and saw plates, pay seven-twentieths of a cent a pound when valued at one cent per pound or less, if not thinner than 140 one-thousandths of an inch, and 0.5 cent if valued between one and three cents a pound. Over three cents, the duty is 20% ad valorem. Duty on all other sheets is proportionally increased. Muck bars and bar iron from one-fourth to five-tenths of a cent a pound. Iron slabs and blooms or any form more finished than pigs, except castings, 0.2 cent per pound. If charcoal iron, 0.3 cent per pound.

Manganese ores containing excess of 30% metallic manganese pays one cent per pound on manganese therein; molybdenum ore or concentrates, 75 cents per pound on molybdenum therein, tungsten ore 45 cents per pound; ferromanganese containing an excess of 1% of carbon, 2 1-5 cents a pound on manganese therein. Other ores and concentrates pay duties on metallic contents therein as follows:

Manganese metal, manganese silicon, manganese boron and ferromanganese containing less than 1% of carbon, 2 1-55 cents per pound on the manganese and 28% ad valorem. Ferromolybdenum and other alloys $1.25 per pound and 17% ad valorem. Ferrotungsten and other alloys 72 cents per pound and 15% ad valorem. All other alloys of tungsten pay the same duty. Silicon alloys from 2½ cents to 8 cents per pound. Ferrochromium with 3% of carbon and 3½ cents per pound. If with less than 3% of carbon and chrome, 30% ad valorem. Vanadium, ferro-phosphorus and all other alloys used in manufacture of steel not specially provided for, pay a duty of 30% ad valorem.—"Boston News Bureau."

MAJOR F. H. MOODY, B.A.Sc.

Major F. H. Moody, who has recently become associated with Powley and Townsley Limited, with head office at 907 Excelsior Life Building, Toronto, as Secretary Treasurer and Chief Engineer, will prove a most valuable acquisition in maintaining the progressive policy of such Company. They deal exclusively in a most complete line of electric industrial and mine-haulage equipment, also handle the highest type of battery-charging and control apparatus and specialize in the sale of the Edison nickel-alkaline storage-battery.

MAJOR F. H. MOODY.

Major Moody has had a varied experience that will prove both practical and useful in his new duties, an experience that will be of real worth to their already numerous and growing clientele.

Major Moody commenced his engineering experience in 1903 as machinist's apprentice with the John Inglis Co. Limited, Toronto. This was followed by the Mechanical and Electrical Engineering course at the University of Toronto, for which he received his degree of Bachelor of Applied Science (with honors) in 1909. The vacation periods were spent in practical work with the General Electric Company, Schenectady, N.Y., American Locomotive Company, Schenectady, N.Y., and International Steam Pump Company, East Cambridge, Mass. Following a year as Demonstrator in Thermodynamics at the University of Toronto, he was successfully Associate Editor "Canadian Machinery," "The Power House" and "Canadian Foundryman," Toronto; Associate Editor "Machinery" New York; and "Canadian Railway and Marine World," Toronto, until July 1915, then he joined up with the 83rd Battalion for overseas service. He served three years overseas with the 116th Battalion C.I., with them he attained the rank of Major. Returning to Canada with that unit in March 1919, he became Assistant Chief Engineer, McLaughlin Motor Car Company, Oshawa, relinquishing that position in January this year to assume the above new duties.

South Africa is very desirous of having a steel industry in the Union, and the coal industry has in recent years made great advances there.

MANGANESE.

The Imperial Mineral Resources Bureau has published a note on Manganese covering the period 1913 to 1919 inclusive. Definitions of manganese-ore minerals and a list of their uses are given. About 95 percent of the world's production of manganese ores, manganiferous iron-ores, and manganiferous zinc-residuum is used directly or indirectly in the manufacture of steel as a deoxidizer.

British India is the world's most important producer of manganese, although before the war Russia was foremost. Russia's record production of 1,234,900 tons in 1913 is now seen as forecasting some later events. Whether Russia is producing manganese ores or not at this time does not appear to be known. The more important producers during 1913 and 1919 were as follows:

Production of Manganese Ore (Long Tons).

	1913	1919
Russia & Georgia.. ..	1,234,900	
British India..	815,047	[illegible]
Brazil..	120,335	319,777
Spain..	21,247	65,514
Italy..	1,596	30,345
United States..	4,048	55,322

Great Britain herself produces a little manganese ore. 17,456 tons in 1918 and 12,078 tons in 1919 having been mined in the United Kingdom. British countries producing manganese include also the Gold Coast, Union of South Africa, Australia, but Canada has not in recent years produced more than a few hundred tons annually. In Egypt (West-Central Sinai) valuable manganiferous deposits are reported.

The Report states that during the war Brazilian and other available ores were imported into the United States without the regard for cost that would have influenced buyers in normal times; but, with improved railway transportation from the State of Mines Geraes to Rio de Janeiro and better facilities for loading at that port, the Brazilian manganese ore industry, while continuing to find its best market in the United States, may perhaps become a more formidable competitor with India and Russia in European markets, although, when normal conditions are restored, Germany will certainly again obtain practically all her manganese-ore supplies from Russia.

The particulars regarding occurrence and development of manganiferous deposits in all parts of the world are very full, and accompanied by a mass of statistics.

The monograph can be obtained from H. M. Stationary Office, London, price 3s. 6d. plus postage.

NEW OXYGEN PLANT AUGURS INDUSTRIAL IMPROVEMENT.

In these days of general industrial depression it is refreshing to note the spirit of optimism evidenced in the announcement recently authorized, that the Dominion Oxygen Company, Limited, will break ground in mid-July for a new quarter-of-a-million-dollar oxygen plant at Montreal, which will double the company's present capacity. The building will be 100 ft. x 100 ft., and will be substantially a duplicate of the company's Toronto plant, which until now has supplied oxygen to Canadian industrial users through five district distributing stations. The Montreal plant will be the second of five producing plants projected at the time the company was organized last year.

THE LATE GEORGE BLAKE WALKER—COAL MINER AND SCIENTIST.

By the death of George Blake Walker, at the age of 67, British coal-mining loses one who was a leader in all improvements in the methods of coal extraction and utilization. His grandfather, father and himself were successively in charge of the Wharncliffe Silkstone Colliery from 1853 until within a few years ago. In connection with this colliery undertaking many of the now approved modern practices in coal-mining were first tried. The first by-product coke-ovens in the Midlands Coalfield (if not the first in Britain) were erected by the Simon-Carves Company at Wharncliffe Silkstone Colliery about 1890, and at this colliery, coke-oven gases, after extraction of the benzol and other by-products, were used to drive gas-engines, and to provide motive-power for the air-compressors and electric-lighting. Coal-cutting machinery was installed at a very early date in these collieries, and at a neighbouring colliery, Mr. Walker was instrumental in introducing the use of the first electrically-operated coal-cutter to undercut a seam under two feet in thickness.

THE LATE GEO. BLAKE WALKER.

Mr. Walker was responsible for the introduction of the first oxygen-breathing apparatus into British coal-mines, and the Tankersley Rescue Station, for which he was also chiefly responsible, was the first in Britain. He was also a pioneer in the introduction of pit-head wash-houses, and took a lively interest in all housing schemes for coal miners.

His labours for the scientific advancement of coal mining covered a long period. He was a Fellow of the Geological Society, and was the first lecturer in coal-mining at Firth College, Sheffield. His exertions in the formation of the University of Sheffield, and particularly in its coal-mining activities were recognised in 1918 by the honorary degree of Master of Engineering from that University. He was one of the original members and an ardent supporter of the Midland Institute of Mining & Mechanical Engineers, being President from 1896 to 1898, and Honorary Secretary until 1918. He was the first recipient of the Peake Medal for conspicuous service to the mining industry. In 1918, his great services were recognised by his election as President of the Institution of Mining Engineers, and he also received the Telford Medal and premium from the Institution of Civil Engineers, of which he was a member. He was a member and President of the Sheffield Society of Engineers and Metallurgists.

Mr. Walker lived and worked among his employees from a boy, and in 1916, after 42 years continuous residence and service with the Wharncliffe Silkstone Collieries, his workmen presented him with a portrait in oils as a token of their esteem. The Wharncliffe Silkstone Colliery is historical in that it had the first checkweighman appointed under the Coal Mines Regulation Act, and it was the first colliery to have a miners' union.

As a consulting mining-engineer, Mr. Walker visited Australia and Canada on numerous occasions, and his health was impaired by hardships experienced in a blizzard while examining coal properties in the Rocky Mountains in 1909. He made two reports on the properties of the Dominion Coal Company in 1904 and 1907. He visited Canada in 1919 again.

As a pupil of Mr. Walker's, and as one of many who received many personal kindnesses, and wise direction, encouragement and help in mining studies, from a man who always regarded mining education as a life-mission, the Editor desires to express his gratitude for the example of a good man, of great scientific attainments, actuated by the highest ideals, whose probity was never challenged. In addition to his eminence as a mining engineer, Mr. Walker was a musician and composer, and published several volumes of verse. It was a privilege and an honour to be intimately acquainted with such a man, whose comparatively early passing will cause regrets in the many quarters of the world where his former employees and pupils are scattered.

A Jarosite Deposit in Victoria, Australia.

"Chemical Engineering & Mining Review," Melbourne, in the issue of March 5th reports the existence of well-defined seams of jarosite in the cliffs near Anglesea, Victoria. This little-known mineral is described as a basic sulphate of iron and potassium, and in composition corresponds to its better-known sister mineral, alunite, which is a basic sulphite of aluminium and potassium. Jarosite may be described as alunite in which iron has taken the place of aluminium. Economically the mineral can be made to yield sulphuric acid, and pigments, and a company is being formed to develop the deposit for commercial uses. Jarosite is a bright yellow mineral, and is sometimes known as yellow iron-ore. The deposits associated with the jarosite seams are carboniferous sands, containing much pyrites and casts of leaves, and in one place a definite seam of low-grade coal is observable. The jarosite seams are thought to have been formed by leaching of the pyrites by water and subsequent concentration of jarosite in jointings of the carboniferous sandstone.

REPORT OF THE DOMINION STEEL CORPORATION FOR 1920

The report of the Dominion Steel Corporation, for the fiscal year ending March 31st 1921, shows production comparing with two previous years as follows:

	Fiscal Years — Tons		
	1920	1919	1918
Pig Iron	207,678	184,229	307,863
Steel Ingots	243,565	219,943	341,603
Blooms and Billets*	68,994	26,165	47,890
Standard Rails	7,486	68,976	164,972
Light Rails	3,985	3,319	......
Wire Rods	55,853	44,436	26,746
Bars	2,207	1,245	1,459
Wire†	23,122	15,542	6,043
Nails	15,556	12,386	5,508
Plates	38,894	3,252	......
Coal	3,563,954	3,502,069	3,622,644

* For sale.

† Includes wire used in making nails.

With regard to production, the Report states it was possible only to operate the steel works upon a satisfactory scale during half the year. The cancellation by the Government of its contract for ship-plates, the abrupt change in export trade, coupled with general slackness in the domestic trade, and the fact that large stocks of ore, limestone, and ferro-manganese had been provided for the Winter of 1920-1921, account for increased inventories. It was necessary to bank a large tonnage of coal during the Winter. Inventories, after making provision for decline in market values, compare with two previous years as follows:

1920	$11,243,286
1919	9,490,369
1918	9,314,602

The net addition to cost of properties was $4,592,211, principal items including sixty new Kopper's by-product coke-ovens, begun in April 1920 and now approaching completion; payments against steamships acquired in settlement of claims for breach of charter, final payments upon plate-mill and powerhouses at the Sydney Steel Plant, and the erection of works for making silica and firebrick.

Provision for depreciation and renewals during the year amounted to $1,583,662, an increase of $316,806 over last year's deduction. After writing off $349,505 expended during the year to replace obsolete equipment, the balance remaining in reserve for depreciation is $16,711,020, which the directors believe to be sufficient for this purpose.

Largely owing to increase of stocks on hand, the quick assets have decreased $1,347,162 and current liabilities have increased $657,554, making a decline in working capital amounting to $2,004,716. This is more than offset by the increase of $4,592,211 in the value of plant.

The profit and loss account for three years compares as follows:

	1920	1919	1918
Op. income	$7,212,751	5,532,529	8,768,054
Depreciation, etc.	1,583,662	1,266,856	1,304,323
Balance	5,629,089	4,265,673	7,463,731
Interest	970,777	1,004,060	1,013,263
Net Income	4,658,312	3,261,613	6,450,468
Preferred dividends	980,000	980,000	980,000
Net Profits	3,678,312	2,281,613	5,470,468
Common Dividends	2,226,000	2,029,629	1,765,373
Surplus	1,452,312	251,984	3,705,095
Add previous Surplus	8,211,236	7,959,252	13,754,157
Total Surplus	9,663,548	8,211,236	17,459,252
Reserve			9,500,000
Balance March 31st	9,663,548	8,211,236	7,959,252

The earnings shown are at the rate of virtually 10 per cent on the common stock, which compares with 6.1 per cent in the previous year.

A condensation of the consolidated balance sheet for two years is as follows:

ASSETS	1920	1919
Properties, less deprec.	$83,217,835	79,861,901
Trustees	163,833	145,751
Current	20,706,403	22,053,566
Deferred Charges	571,159	583,985
Totals	$104,659,231	102,645,204

LIABILITIES		
Funded Debt	$20,067,659	20,450,682
Deferred Payments	182,200	208,000
Current	10,258,391	9,600,836
Reserves	2,387,633	2,074,448
Capital Stock		
Preferred Stocks	15,000,000	15,000,000
Common	37,100,000	37,100,000
Surplus		
General Reserve	10,000,000	10,000,000
P. & L. Balance	9,663,548	8,211,236
	$104,659,231	102,645,204

As compared with the previous year, the report of the Dominion Steel Corporation is surprisingly good. Its outstanding features are a large increase in operating earnings, a decrease in bonded indebtedness and a larger equity behind the capital stock than has yet been recorded by the Corporation.

References to changes in organization and the British Empire Steel consolidation are made in the Report, but as these have been previously published in "Iron and Steel" it is not necessary to repeat them.

EDITORIAL

WORKING CAPITAL OF CANADIAN STEEL COMPANIES.

The Toronto "Globe" recently published a statement showing the working capital of representative Canadian industrial companies at this time, and during 1918 and 1919, in comparison with the figures of 1914. Allowing something for currency inflation and the possibility of an insufficient depreciation of inventories, the figures are, on the whole, very satisfactory. This is particularly the case with the steel and equipment companies. The combined working capital of four companies, namely, Dominion Steel Corporation, Nova Scotia Steel & Coal Company, Steel Company of Canada and Ontario Steel Products, was in 1914 roughly $9,800,000. At the end of 1920 it was estimated to be $28,950,000 or $19,150,000 in excess of the 1914 totals. When it is remembered that in 1920 all the necessary allowances for depreciation of munitions machinery had been made, that inventories had undergone much reduction from the high prices of 1919, and that many improvements to plant had been paid for out of revenue, an appreciation of over nineteen million dollars indicates real progress towards financial strength.

A similar calculation in regard to a group of equipment companies, including Canadian Car & Foundry, Canadian General Electric, Canadian Foundries & Forgings & Canadian Locomotive, shows an appreciation in working capital in 1920 as compared with 1914 of six million dollars.

While the state of the metals and equipment trades is not roseate at this time there seems good reason to believe that basic conditions are fundamentally improved and that the worst of the strain has passed in financial circles.

At no time in the history of the iron and steel and equipment trades in Canada was the capacity of plants so great as today, or the statement of the equipment so modern and efficient. If any further waiting period lies ahead for business, it may be observed that the Canadian companies are better fortified to meet it than ever before, and, compared with the larger and rather unwieldy industrial leviathan in the United States, our domestic steel industry is comparatively well employed during the Summer, although, admittedly, the outlook for the Winter is not promising. As previously suggested, if the process of using up financial reserves to provide employment for working organizations is to be continued, some very substantial reductions in labour costs will have to be made, and the sooner a mutual agreement is arrived at, the sooner it will be possible for Canadian steel companies to furnish employment, and the sooner will some permanency of employment become assured by placing of purchasing orders.

THE MOOTED IRON & STEEL INDUSTRY IN BRITISH COLUMBIA.

In this issue will be found a paper read before the International Mining Convention at Portland, Oregon, by Clyde E. Williams, Metallurgist of the United States Bureau of Mines, dealing with the factors concerned in the production of iron and steel on the Pacific Coast of North America. This paper, which puts the relevant considerations very impartially, views the matter of course from the standpoint of the Pacific Coast of the United States more particularly. Another article, also appearing in this issue, is written by the Secretary of the Minister of Mines for British Columbia, and puts forward one phase of British Columbia opinion.

It seems fairly evident, from the data given by Mr. Williams and that quoted from Mr. Nichol Thompson's report to the B. C. government, that there is a real need and a present market for pig-iron on the Pacific Coast, as, under present conditions, pig-iron is really the raw material of any iron and steel activities that exist on the Pacific Slope, and these appear to be quite important.

Mr. Williams puts his finger on the most vital operating consideration when he states "the presence of iron-ore near the smelting locality is not so important as is the presence of coke. Iron ore can be shipped as ballast cheaply from great distances." This decisive factor was clearly emphasised in our July issue by Mr. J. F. K. Brown in his summary of the numerous instances, of world-wide incidence, where iron ore travels to the coal deposit used to smelt it, and a consideration of the arguments marshalled by Mr. Brown (see page 165, July issue) will show that Vancouver Island is fundamentally correct as the location for a blast furnace on the Pacific Coast. The development of an iron and steel industry on Vancouver Island, or on the British Columbia coast region, can, Mr. Brown affirms—and we believe quite correctly—"be consummated with either native or foreign ores."

An iron and steel industry in British Columbia is an undoubted development of the future, and it looks now as if, were the advantages of Vancouver Island fully assessed, and truly valued, it will be chosen by such capitalists, be they American or British, as shall invest money in a blast-furnace plant on the Pacific Slope. Mr. Williams succinctly puts the matter by stating; "the smelting centre should be near the coke-supply in British Columbia or Washington". The excellence of the

coals of Vancouver Island for coking purposes is proven, and is well-known to the coal companies in the Island. The most permanent and logical evolution of an iron and steel industry, so far as British Columbia is concerned, would arise from enlargement of the operations of the existing coal companies on the Island, who possess local knowledge and locally trained staffs, both in executive and operating departments. Mr. Williams probably has the necessity for local knowledge and reasonably slow growth in mind when he remarks that the initial work "must be done by a strong organization, and one with a fund of advice, both technical and commercial." It will be far better if the mooted iron and steel industry in British Columbia proceeds from a natural enlargement of existing corporations, rather than from an incursion of capital, bent on large expenditures, and uninformed and fortified against mistakes by that intimate local knowledge which only local experience can give.

NINETY-FOUR PER CENT OF CANADIAN WATER POWERS UNHARNESSED.

The Dominion Water Power Branch of the Department of the Interior issues a report in which it estimates the minimum water-power possibilities of the Dominion to exceed 18 million horse-power, and a possible maximum (dependable for six months of the year) of 32 million horse-power. The present installations of turbines represent utilisiation of only 5.9 percent of the recorded water-power resources. This present development, representing an investment of $475,000,000 is estimated to provide power equivalent to 18½ million tons of coal annually, or 2½ million tons greater than Canada's largest annual production to date. The sufficiency of the Dominion's water-power reserves is made very plain by these latest and carefully calculated estimates, and it is a matter for satisfaction that 75 per cent of the water-powers are to be found in Manitoba, Ontario and Quebec, precisely the provinces where no bituminous coal is found. The opportunity before those who are interested in the manufacture of water-power machinery and in electric appliances in Canada is therefore very great, nor is there the slightest danger that those who are interested in the development of Canadian coal will ever find the competition of water-power to affect them adversely. Both sources of power will be required for the needs of Canada of the future.

The extent to which electricity may be used in industrial and domestic requirements would seem to depend on the efforts of makers of electrical appliances to adapt these to new uses, and the efforts of power companies to give users of power a dependable supply, not subject to interruptions. There are many industrial plants today, and some domestic establishments also, that preferably use electric power, but find it necessary to keep a steam-power unit as a stand-by.

The excellences of electricity as a motive power are well illustrated at a modern colliery-plant, where, if any where, coal should be moderately priced and always aavilable. Such a plant will use electricity at every possible point, but investigation will show that a steam-power unit, or several, must be kept in reserve because of the liability of electric machines to go out of commission. It is this peculiarity of electric power supply that detracts from its wider use in many communial and domestic uses, as for example in hospitals and domestic heating in a very cold climate. It does not seem that electrical engineers have yet perfected the transmisssion of electric power, and there seems to be very much more certainty in the mechanical dependability of the devices for the generation and use of electric power than in its transmission. A good deal of electrical transmission equipment is old-fashioned and insubstantially built, and it is evident that power companies, as a general thing, have not realized the permanent and growing nature of the public demand for electrical power, or the tremendous possibilities of its generation and supply, otherwise they would have builded better than they did. Some power companies do not seem to have advanced beyond the limited vision of electric-light companies, whereas the supplying of electric light is but a sub-division in the business of generating and supplying electricity today. In many instances, possibly, the franchises and ideas of gas companies have permeated electric-power circles, and limited their vision, as for a long time the design of electric-light fixtures followed the tradition of the mid-Victorian gas fixture.

With 94 percent of the recorded water-power resources of the Dominion undeveloped, it would seem that the Canadian companies that have equipped themselves to manufacture and assemble the large parts required for water turbines have invested well, and should reap due reward as Canadian water-powers are harnessed.

REPEATED SHUT-DOWNS OF COKE OVENS.

In "Iron Age" of 14th July appears a useful and practical article by J. M. Hastings Jr. recording a series of frequent shut-downs of by-product coke-ovens which occurred at a plant near Wheeling, W. Va., and by reason of the taking of proper precautions resulted in no injury to the oven linings. It has long been a tradition among coke-oven operators that if a battery of ovens were allowed to go cold, heavy repairs would be required to remedy the damage resulting from contraction, and it has often been necessary to incur heavy expenditure to maintain sufficient heat in by-product ovens to prevent the consequences of shutting-down the ovens completely. The type of oven, and the provision of ties and stays permitting adjustment to varied stages of expansion and contraction, is probably a deciding factor, and, where the necessity for shut-downs is apprehended, it would appear advisable to give consideration to this point. Mr. Hastings' article is reproduced in this issue.

IRON ORE IN ALBERTA.

The Second Annual Report of the Province of Alberta on Mineral Resources mentions two reported occurrences of iron ore in that province of large area, and in neither case are these occurrences of economic importance. A twenty-foot bed of hematite in the Mackenzie River Valley, near Wrigley, apart from its remote location, while apparently of quite large extent, is low in iron and siliceous, and would not be mined were it situated in a more accessible part of the country.

The reported occurrence of iron along the Sheep River, which has been used as a basis for company promotion is again summarily dismissed by Dr. John Allan, who says "there is not a ton of rock in the district that can be classed as iron ore."

It is well that correct information should be given regarding any occurrence of iron-bearing rocks in Alberta, because in this province of tremendous coal resources the presence of iron ore is a matter of the utmost importance. So far, iron-ore of merchantable quality has not been discovered in commercially workable quantity, but the presence of coal in Alberta is of such significance that any really worthwhile iron-ore deposit within reasonable transportation distance of the coal seams would possess unusual value, whether it was actually in Alberta or not.

WHAT IS WRONG WITH COST ACCOUNTING.

During the insistent demand of the war years, manufacturers counted their profits by the extent of their sales and did not worry much about cost of production. Excess profits taxes and the fluctuating value of money combined to make directorates neglectful of unit costs of production, and a very general laxity in organization and accounting resulted. There was little inducement to spare expenditures when the tax-collector stood waiting for all unusual profits, and when workmen were scarce and quick to run away to more profitable employment, it was not accounted good policy to scrutinise statistics of working forces and production costs too closely, or at least to the point when economical action might be revealed as incumbent upon a worried executive officer.

Today conditions are very different. Commodity production is down to a competitive basis, and production costs of an accurate character are the first thing that the officers of industrial corporations call for.

The war period, with its government control and bureaucratic experiments in finance, has revealed the essential inaccuracy and partial character of much of what passed for good practice in cost-accounting in previous years. It has been realised that many systems of cost accounting attempted to accomplish too many purposes at one time and with one set of records. There are at least three distinct purposes served by production costs, and they should not be mixed up. The operating superintendent requires to have cost information that will enable him to check the expenditure of labour and material that comes under his direction, and he requires this information not later than the day of expenditure, or at least the day after. That is to say, he requires daily costs. The general manager requires a daily cost also, but the information he must have, to fix sales-prices and direct operations generally, must contain items of overhead expense, and can be arranged for presentation in weekly, monthly, or such other seasonal periods as may be necessary. The directorate and the general manger, for the broader purposes of financing and wider purview, require financial statements and production costs that take in the life of the concern. Too often, a compromise system is adopted that does not give anybody the information he wants, at the time it is necessary to have it.

Our readers will do well to peruse the article, reprinted in this issue from the first number of "Management Engineering", and particularly the statements made as to "the lack of practical value in detailed cost data presented fifteen days after the end of the month... and the absurdity of calling foremen to account for events which happened four or five weeks previously... of cost systems designed to show monthly costs without reference to standards".

Many cost-accounting systems deal exclusively with dollars and cents. They do not take into account the details of or the distribution of workmen. They pursue dissections of labour and material to such an excess that they destroy the very criteria by which an operating superintendent sizes up his work, namely the kind of labour performed in a given department and the number of men that performed it.

There is no doubt that general confirmation among operating men will be given to the statement made in the article quoted from, namely, that the best proof that customary accounting-methods do not meet the needs of the operating man "is the fact that in large plants it is the rule rather than the exception to find that a subsidiary cost-system is operated for the sole purpose of furnishing the works manager with cost information which he cannot obtain from the official cost system."

The question "what is wrong with cost-accounting" may be partially answered by replying that many works-costing systems have been forced upon engineers by book-keepers. Cost accounting in a manufacturing works of modern complexity is distinctly not a book-keeping matter, as that term is usually employed, and the education of a chartered accountant will not give him any equipment for devising records of unit costs, although he may know all about the theory of amortization and of interest. Unit cost records of an engineering operation are distinctly an engineering problem, and, while no reasonable operating man will decline the aid of the accountant, yet it is certain that unit costs of production will never be sufficiently accurate, or sufficiently timely, until they are drawn up by men familiar with every detail and complexity of the technical operations that it is desired to record, and until they are primarily designed to present quickly, in an understandable form, for the consideration of the men

who direct the expenditure on these operations, the information they require.

It is quite possible, and has very often happened, that a cost-sheet which is most desirable and efficient for the purposes of the directorate is entirely unsuited to the detection of waste and inefficiency in production. As the profits which any directorate may have to administer, and losses also, are made in the operations of production, whose necessities should be given first call? "Accountants are liable to overlook the fact that a manufacturer is in business for the primary business of making money" it is stated. This is rather a bitter saying, but perhaps it might be softened by paraphrasing it into the statement that cost accountants should make their systems to serve the primary and also the ultimate end of saving money. If this were done, it would be found that the works manager and his subordinates should be supplied with the kind of cost records which they considered they required, irrespective of tradition, or of "that form of cost accounting which views costs in the retrospective sense only."

WE had always supposed that the traditional incompatability of opinion between the East and the West was a Canadian idiosyncrasy, but the debate in the House in the United States upon the Fordney tariff bill discloses that this custom, like high tariffs and the class consciousness of the agriculturist, comes from the South. The "Boston News Bureau" refers in rather unBostonian heat to "the Western oligarchy in the House" and regards the tariff bill as "very pettish prejudice", which possibly its proponents feel "is a piece of revenge—retribution by the West upon the East."

It is a peculiarity of the development of North America, that, proceeding as it did from the settlement of white men on the Atlantic Coast, the East should have become urban and industrially developed before the West. From the standpoint of natural resources, however, when settlement shall have been completed in North America, the West is much better provided with the basis for the textile, shoe, iron and other industries that have played so prominent a part in the East, and it is a commentary on the times that the cry of the West for protection against the supposed tyranny of the East should have now changed to pleas from the East against western dominance. We believe there is no conflict between the East and the West, but only just a little discrepancy in date of development, and that future generations will laugh at a mentality which presupposed some necessary hostility between them. In the meantime, the great business of North American politicians, on both sides of the line, is to preach the essential solidarity of East and West, because they not only meet, but their interests commingle and are inextricably blended.

SUBMARINE MINING EXPERT IN CANADA.

The Chief Mineral Inspector of the Department of Woods and Forests in Britain, Mr. Westgarth Forster Brown, is visiting the mines of the British Empire Steel Corporation in a professional capacity as an advisor on submarine coal mining. The coal lying beyond the foreshore in Britain—with one exception—is the property of the Crown, and its administration and leasing for operation comes under the direction of the Department of Woods and Forests. Mr. Brown will consult with the mining staff of the Corporation as to submarine mining practice in Cape Breton, and will probably visit the ore mines at Wabana. The British Empire Steel Corporation is now operating twelve mines in the Sydney district which are wholly submarine operations, and its existing land mines will, by a course of natural extension eventually become submarine operations also. Additional openings from the shore on submarine territory will also be made in the future. As miners of the submarine iron ore body at Wabana, Newfoundland, in addition to its coal mines under the sea, the British Empire Steel Corporation directs the most extensive undersea mining operations in the world, and its submarine workings are likely to become much more extensive both as to area and as to distance of penetration of the submarine tracts from high-water mark.

"Germany has lost by war and now sees that her only hope of winning or even existing is by labor.

"Germany is fooling the world by setting it an example of eight hours a day in legal enactment, but as a matter of fact is working eight hours a day only where there is not work enough to go around. Whereever there is work to be had her forces jump into piece work and work 12 and 14 hours. Germany is poor and starved and still she is fooling the whole world, for she has given her cloak and old clothes of militarism over to France, England, Japan and the United States while she herself, stripped to the bone, with no fat and no bellies, is building railroads and harbors, spinning the world's rejected cotton and doing whatever she is told to do by the allies, who are sparring among themselves and wasting their substance in militarism and taxes to the destruction of themselves and nobody else, and in the last analysis for the sole benefit of Germany.

"Germany has now an industrial army, while France, England, Japan and the United States are impoverishing themselves with an annual expenditure for armies and navies that could open up all of Africa and China and make these great continents sources of cheap food supplies and enormous consumers of our surplus products, and do it without in the least upsetting the world's economic foundations. — C. W. Barron.

Col. David Carnegie, who was a member of the Munitions Board in Canada during the war, has recommenced private practice as a consulting engineer in London. Col. Carnegie, in addition to his experience as an ordnance and metallurgical engineer, has always taken a deep interest in industrial arbitration having, it will be remembered, read a paper on the Whitley Scheme before the Canadian Mining Institute during the war and he is prepared to give advice and personal services in arbitration work.

The Manufacture and Use of Manganese Steel

By Col. DAVID CARNEGIE, M.I.C.E., F.R.S.
Edin, etc.

At the forthcoming 1921 Conference of Engineers at the Institution of Civil Engineers, London, the "John Fritz Medal" is to be awarded to Sir Robert Hadfield, Bart., as a recognition by the American Engineering Societies of their appreciation of the services Sir Robert Hadfield has rendered to science, particularly in relation to his discovery of the manufacture and use of Manganese Steel. It is an honour well deserved. Sir Robert is an inveterate worker and has the charm of making those around him share in the value of his research.

It is considerably over twenty years since the production of manganese steel for commercial purposes was an assured fact, and yet to-day there are few steel manufacturers who have taken up its manufacture seriously in connection with the many uses to which it can be employed.

A few details regarding the manufacture of this steel and its use may be of interest to Canadian manufacturers.

The successful manufacture of manganese steel depends upon at least five things:—

1. The design of castings.
2. Good moulding.
3. Correct analysis of material.
4. Method of steel making.
5. Proper treatment.

Considering these in their order, I would point out the following:—

1. Design of Castings.

From a rather considerable experience in the manufacture of manganese steel in different forms, I think that the most important things to observe in the design of patterns are:—

First: Uniformity of thickness;

Second: Maximum thickness;

Third: Contraction limits.

It is well known that the contraction of manganese steel, while cooling in the mould is 5-16ths of an inch for every 12 inches, as against 3-16ths of an inch per 12 inches for ordinary carbon steel. This fact alone calls for careful design in the pattern to allow for that freedom in contraction which is necessary.

With regard to the uniformity in the thickness of castings, while it is necessary to keep this in view in the design of patterns for ordinary cast steel, it is more essential to be observed in regard to the design for manganese steel castings.

Contraction cracks at the junction of two parts of dissimilar thicknesses is not uncommon during cooling or in subsequent "water toughening". It is also known that the practice of leaving sharp corners in steel castings between parts which differ in thickness is deplored, and that in addition to curved corners being required, small brackets are used between such parts to prevent "pulling". The same precautions are more necessary in manganese steel castings, where the design cannot be made so that all adjoining parts shall have a gradual variation in thickness.

With reference to the maximum thickness of any part of a manganese steel casting, it is most advisable that it should not exceed 3 inches, and it is very much better, if possible, to keep the limits within 2 inches and 2½ inches. When castings even of uniobtaining differing results in their treatment, as the form section exceed this thickness, a risk is run of steel, after "water toughening", does not possess uniformly throughout the same value. This rule is not always observed, for instance in the case of shoes and dies for stamp-mills, manganese steel has not given that satisfaction which has been expected because their design did not admit of making the cross section of the die smaller.

There are many other points in regard to the design of patterns for manganese steel, which though apparently insignificant are often of much value in producing satisfactory steel castings.

Good Moulding.

The fact that manganese steel castings contract 5-16ths inch per 12 inches calls for more attention in the careful making of moulds.

I particularly draw attention to sand moulds for manganese steel, as the composition of the sand is often responsible for curious small surface cracks which can be traced to a want of freedom in the mould yielding to the necessary contraction of the liquid manganese steel.

Moulds which are not well liberated sometimes produce internal weakness in the thicker parts of castings. Such castings when broken indicate that the fractures have taken place during cooling, and yet curiously enough the external part of the casting may appear perfectly sound. Such defects are usually revealed during the process of straightening or hammering the casting to correct any irregularity in the shape after water toughening. It is always advisable to have as few contraction brackets as possible, or other devices for holding thick and thin parts together. It is far better to depend on good designs of patterns and on well-made moulds than on contraction brackets and the like.

It is quite unnecessary to use dry-sand moulds for plain manganese steel castings if they are not too thick. Cheek and wearing plates, for instance, used in crushing and stamp-mills, and elevator plates, etc, are made in green-sand moulds with satisfactory results.

Heavy and intricate manganese steel castings require very refractory moulding-sand, well dried, to produce clean castings.

Analysis of Materials.

It is rather curious that in manganese steel there are perhaps more "freaks" than in any other steel with which the steel foundryman has to deal. Two steels bearing the same analysis and receiving the same treatment may give different physical tests. At the same time there are manganese steels containing slightly different chemical elements which are known to give, as a rule, trustworthy results.

Classes of Manganese Steel.—Manganese steel is made in different qualities according to the class of work required. If, for instance, ingots are required

to be forged or rolled into bars for various purposes, it is not advisable to have more than 1.0 to 1.1 per cent of carbon, with 0.2 to 0.3 per cent silicon, and approximately 12 per cent of manganese. Forged manganese steels are sometimes made, having a lower carbon-content, and although they are tough, they do not wear so well as those with higher carbon-contents, such as given above. On the other hand, for some classes of manganese steel castings as much as 1.5 per cent of carbon and even slightly more than this is used. With such high carbons, it is only advisable to make plain castings of uniform section, where the very hardest wearing properties are required.

The normal range of carbon content in manganese steels is from 1.0 to 1.5 per cent for most commercial uses. Manganese steel containing the lower limits of carbon is less liable to fracture while being forged and rolled hot than manganese steel containing higher carbon content. With regard to manganese steel castings, those containing the higher ranges of carbon are more liable to fracture in the water tempering treatment than steel with lower carbons.

Only with considerable experience of the wearing parts for crushing, mining and dredging machinery is it safe to determine what are the most suitable amounts of carbon to use in the steel to give the best results for the parts used.

With reference to the phosphorous and sulphur contents of manganese steel, it is not necessary that they should be lower than that used in ordinary carbon cast-steels.

It is really immaterial what process of steel making is adopted for the melting of the charge prior to the addition of manganese. Perhaps more manganese steel has been produced from the Bessemer converter than from any other type of furnace. The usual, reliable and economical process is to melt the ferro-manganese in the crucible furnace, and afterwards pour it into the large casting-ladle just before the contents of the furnace are tapped or poured into the ladle — This affords a good opportunity for the manganese to mix well with the steel. This method is employed when the whole charge is required for manganese steel, but when making small charges of manganese steel, the practice is to put a casting-shank or small ladle on a weighing machine and pour a measured quantity by weight of melted ferro-manganese from the crucible and afterwards fill up the shank with low-carbon steel from the large casting-ladle. This answers well for one or two hundred-weight lots of steel, and is a convenient way of taking part of an ordinary charge for this purpose. When melting steel in the electric furnace, the ferro-manganese can be added direct to the charge in the furnace before tapping.

The Treatment of Manganese Steel.

The treatment of manganese steel depends upon the nature of the casting and the carbon content of the steel of which it is made. It is of course assumed that the manganese content is kept to about 12 per cent. Lower percentages of manganese in the steel are not found as a rule so satisfactory.

Plain castings can be left to cool in the moulds or on the foundry floor, when taken from the moulds, at a black heat without risk of fracture. If the sand moulds are made properly, the sand should fall or be removed from the surface of the manganese steel even more rapidly than from ordinary steel castings. "Heads" on manganese steel castings should be avoided as much as possible. Numerous small "risers" should be placed at suitable positions on the castings which can be broken off with the stroke of a hand-hammer when the castings are quite cool. It is usual and best to fettle or dress plain castings before heating them for water toughening.

For plain castings, containing lower percentages of carbon, no danger whatever exists in putting them straight from the cold state into the furnace at 400 or 500 degrees C., and raising them quickly to 850 or 1,000 deg. C., at which temperature it is only necessary to let them soak for a short period. It is important, however, that uniform heating be established, after which the castings may be plunged into cold water. It is essential that castings of large and heavy sections be taken from the moulds soon after casting, fettled and cleaned quickly and that any "runners" and "risers" be knocked off which can be done without injury to the casting. The casting should then be placed in a furnace which should be about the same temperature as itself. The temperature of the furnace should then be raised gradually and maintained for a period depending upon the kind of casting, until the proper quenching-temperature is obtained, after which it should be withdrawn from the furnace and water-cooled as quickly as possible. It is important that the type of cooling-tank should be of special dimensions and design to insure uniformity in cooling.

In the foregoing account of manganese steel and its uses, I have refrained from telling of its particular properties, apart from its special commercial value in industry, believing that the general characteristics of the metal are well known. Lest, however, this article be read by any who are unfamiliar with the physical properties of manganese steel, I would here mention that in its cast "untoughened state", the material is quite brittle, resembling in many respects ordinary Cast-iron. When "water toughened" in the manner previously described, a remarkable change occurs, which gives to the material a tenacity of from 50 to 60 tons per square inch, with an elongation of from 30 to 40 per cent in two inches. In spite of such ductility the material is so hard that it is almost impossible to machine it with ordinary tools — Finished surfaces are therefore ground with emery and other wheels. All manganese steel is non-magnetic.

I see no reason why the development of manganese steel castings manufacture for mining, crushing, dredging, and tramway and car work should not take place in Canada.

PORT ARTHUR PLEBISCITE FAVOR STEEL INDUSTRY.

Two by-laws were submitted to the ratepayers of Port Arthur on the 27th July. One confirming the sale of two hundred acres of water-front property by the City of Port Arthur, to the Palatine Mining & Development Company, for the purpose of erecting thereon ore-docks, and an iron and steel industry, together with allied industries, the other confirming a tentative agreement made by the City Council, with the above company, placing a fixed assessment on its blast furnace for a period of ten years.

Both by-laws were carried by practically a unanimous vote, being the largest vote of the kind ever registered here, showing the confidence the local people have in the iron-ore resources of this district, and the possibilities of an iron and steel industry at this point.

Repeated Shut Downs of Coke Ovens

Twenty Years' Experience With By-Product Plant Near Wheeling, W. Va., With Floods and Stoppage for Other Reasons.

By J. M. HASTINGS, Jr.
(From "Iron Age".)

The impression seems to have gained considerable credence that a by-product coke-oven plant cannot be allowed to become cold without serious consequences and more or less complete rebuilding before it can be started again. Some owners are even going to heavy expense to keep their oven plants hot, or are selling coke at a serious loss to avoid a shut-down. A report recently received from a plant of by-product ovens near Wheeling, W. Va., shows that a correctly designet plant may be shut down completely without serious injury.

In 1918 a plant of 60 Semet-Solvay ovens was built for the Riverside Iron Works, now owned by the National Tube Co. at Benwood, W. Va., just outside of Wheeling. Two years later 60 more ovens were added. The plant was built on the flat land along the Ohio River, and although the records of high water were carefully studied for a long period, the progressive denudation of the forests made these records of little value, and three years after the first ovens were started the plant was put out of operation by high water. During the twenty years from April 24, 1901, when this first shut-down occurred, to March 16, 1921, the date of the most recent shut-down, the Benwood coke oven plant has been closed down and started up again twenty distinct times.

Seven times in that period the Ohio has flooded the district and effectively put the ovens out of commission. Most of these interruptions were for relatively short periods, although in each case the plant was kept in operation until water entered the waste heat flues. In March, 1907, however, flood water was high enough to enter the sole flues and reach the oven floors proper, causing an 18-day shut-down, and in April, 1913, the worst flood in the history of the river brought the water into the lower heating flues 15 in. above the floor of the ovens. On this latter occasion a shut-down of 25 days resulted, largely because natural gas for starting up again was not available for some time after the flood subsided.

In addition to interruptions caused by floods, the plant has been down four times on account of coal shortage, twice for repairs to the hydraulic mains and seven times on account of business conditions. Duration of shut-downs from this last cause has ranged from one month in 1914 to a yaer and seven months in 1907 to 1909.

During its entire twenty-two and a half years' existence, the Benwood plant has been shut down 1958 days, or a total of 5-1/3 years up to March 16 of this year, since which date it has again been cold. Several other Semet-Solvay plants have been shut down for varying periods, but none has approached this record and probably none ever will, due to the peculiar circumstances at Benwood.

Notwithstanding this rather remarkable record of shut-downs, the present condition of the plant shows that it has suffered no serious damage. Of course, these extraordinary and repeated stresses on such a large amount of brickwork cannot be encountered without some injury and expense for repairs. But the construction of this type of oven, with the well-known strong division wall between the ovens, was so substantial that any injury occasioned by these vicissitudes has been of a minor nature, as is shown by the following records.

Of all the ovens built in the United States, No.30 oven in block No. 1 at Benwood, holds the record for low repair costs. This oven has been in operation 17 years and out of running 20 times for a total of over five years, and to date has required no replacements whatever in its lining or brickwork. No. 60 oven in block No. 2 is a close second, having required less than $20 expense for brickwork repairs. It should be further noted that the two ovens mentioned at Benwood are both end ovens, which is the point where injury to the structure of the blocks often first appears. The repair records of these two ovens are of course exceptional, but the record of the entire plant has been remarkable, despite the numerous interruptions.

In addition to these repair records on the ovens, the yields obtained at the Benwood plant have been very satisfactory and compare favorably with those from the best modern plants. For the five-year period from Jan. 1, 1915, to Jan. 1, 1920, during which time the plant enjoyed fairly continuous operation, the average results were as follows:

Analysis of Coal Charged.

Volatile	29.9 per cent
Fixed carbon	62.2 per cent
Ash	7.9 per cent

Yields Obtained

Total coke	78.2 per cent
Sulphate of ammonia	24.5 lb. per ton
Light oil	3.11 gal. per ton
Tar	10.0 gal. per ton

These records show conclusively that that plant has not suffered by reason of its many shut-downs and the same should be true for any correctly designed oven plant. Of course it is necessary to exercise care and to take certain precautions when closing down a coke oven plant for an indefinite period. The process is, in general, just the reverse of that employed in starting up a block. The heats should be lowered gradually by a gradual reduction in the supply of fuel gas, so that the contraction of the block will take place slowly and regularly. As this contraction progresses, the tie rods should be readjusted and a close watch maintained to guard against cracks developing.

If the coke is left in the ovens, as is sometimes done when a long shut-down is not anticipated, the greatest care must be used in sealing the ovens as nearly air-tight as possible. The door frames must be kept tight against the brickwork uptake pipes maintained in proper position and charging hole covers sealed tight. With an experienced operator in charge there is no reason why a block of ovens of correct design cannot be shut down for a longer or shorter period, without extraordinary labor or heavy repair expense on starting up.

Factors in the Production of Iron and Steel on the Pacific Coast

By CLYDE E. WILLIAMS, Metallurgist, U. S. Bureau of Mines.

*The question of the establishment of an iron and steel industry on the Pacific Coast has been the subject of discussion and investigation for many years. Such an industry is necessary if the West Coast is to develop and make the most of its wonderful natural resources. The cost of shipping iron and steel products from Eastern points to the Pacific Coast increases their cost one-half if shipped by water and two-thirds if shipped by rail. This same relation held before the War, when the cost of iron and steel and transportation rates were both lower.

Admittedly, cheaper iron and steel are needed. Whether these can be obtained by producing them upon the Pacific Coast depends upon a number of factors. Chief among these are: (1) the supply of raw material; (2) the amount and nature of the market; (3) the size and type of smelting operation.

Coke.—The vital factor in successful blast-furnace smelting is coke. Iron ore can be brought from great distances cheaply, but it is costly to transport coke. Coke represents one-third of the weight and one-half of the volume of the ordinary blast-furnace charge. Normally from 20 to 30 per cent. of the cost of production is due to coke. There are two outstanding characteristics that the coke must have. First, it must be cheap, and, second, it must have the mechanical strength to support the weight of the charge and sufficient hardness to resist too rapid solution by the ascending gases.

There are several coals of good coking quality in the State of Washington. These coals are high in ash and must be washed before being used in the coking process. Even with careful washing, however, the best coke that can be made from these coals contains 15 per cent or more ash. Perhaps the best supply of coking coal for the present consideration is that in the Wilkeson-Carbonado-Fairfax district in Pierce county. Coke made from this coal has suitable physical properties and is sufficiently low in sulphur and phosphorus to be desirable for use in the blast-furnace. Its high ash-content will make necessary the use of more coke than is ordinarily the case, and hence the cost of smelting will be greater. There is some coal in this district whose content of ash can be lowered by washing to 7.5 per cent. Coke made from this product would contain only 12 per cent ash. Unfortunately, however, this coal is said to be non-coking.

There are coking coals in British Columbia at Cassidy and Cumberland on Vancouver Island, and in Nicola valley and Crows Nest Pass on the mainland. A coke is being made in by-product ovens at Anyox by mixing the high-volatile coal found at Cassidy with the low-volatie coal obtained elsewhere. It is said that this coke has suitable physical properties for use in the bast-furnace. The ash-content is high and it is doubtful if any coke can be made from British Columbian coals that will be lower in ash than that made from the Pierce County coa. Indications are that the ash-content will be higher.

A large quantity of coking coal has not been developed in Oregon. It is said, however, that the Eden Ridge (Coos county) coal is of coking quality.

California has no coking coal. Utah coke of excellent physical qualities and low ash is available, but only after a long rail-haul that approximately doubles the cost of the coke.

From the above information it is evident that coke is available in British Columbia and in Washington, that this coke is suitable for blast-furnace use, and that its cost will be more than the cost of coke in Eastern districts because of its high ash-content and the higher cost of mining it. Coke should not be moved great distances, and Utah coke should not be shipped to California. The smelting centre should be near the coke-supply in British Columbia or Washington.

Iron Ore. The presence of iron ore near the smelting locality is not so important as is the presence of coke. Iron ore can be shipped as ballast cheaply from great distances. No large deposit of iron ore is found in Washington. However, if a smelter were established in the North-West, the many small deposits would undoubtedly be drawn upon.

Magnetite occurs in British Columbia on Texada, Louise, Redonda, and Vancouver islands, and on the mainland to the north of these islands. Some of these deposits contain as much as 60 per cent iron and some only 50 per cent. In some instances, the content of sulphur and copper is so large that the ores must first be purified; in others, no pre treatment is necessary. A large tonnage of these ores is said to be available, but their true extent and composition will only be determined when a market has been established and large-scale mining operations are carried out.

There is a vast supply of high-grade hematite ore in southern California in the Eagle mountains, of Riverside county, and in the Cave Canyon district and in the Providence mountains of San Bernardino county. These ores are rather far inland, but fortunately not far from a railroad. It is probable that other ores nearer tide-water can be obtained at less expense.

Large supplies of high-grade hematite occur in Mexico, the most accessible to the Pacific Coast being those on the west coast of Lower California at St. Vincent. Other deposits in Mexico near the west coast are in the States of Guerrero, Michaocan, and Oaxaca. These ores could be brought to the North-West on returning ships that carry lumber to the Southland. In the same way, the rich Chinese ores could be brought over on ships that carry goods from Pacific Coast ports to the Orient. If this country is to engage in a profitable export business with the Orient, our ships must not return therefrom without cargoes.

Summarizing the facts, sufficient ore of good quality can be brought to an iron smelter on the Pacific Coast; the rich ores of the west coast of Mexico and of China offer the greatest potentialities; the magnetites of British Columbia are available at tide-water, and the hematite of southern California can be obtained at tide-water after a rail-haul of about 200 miles.

Limestone. The limestone at Roche Harbor, on San Juan island, that near Blubber Bay, on Texada island,

* A paper presented at the International Mining Convention at Portland, Oregon, on April 7, 1921.

and that near Cape Flattery, on Vancouver island, are available for use in the Puget Sound region. Sufficient limestone to maintain a plant in southern California may be obtained in San Bernardino county.

Refractories. Clay for refractory purposes is available at Clayburn in the south-western part of British Columbia, just across the line into north-western Washington at Sumas; also at Clayton, and Freeman, near Spokane, and at Moscow and Troy, both in Idaho. That at Clayburn is now being made into good firebrick and that at Sumas can be mixed with Kummer (Washington) flint, an excellent brick being obtained.

Market. Much difference of opinion exists as to the scope of the market for iron and steel on the Pacific Coast. It is difficult to obtain reliable data. The customers are scattered over such an extensive area, and their purchases are so variable in amount and kind that it is almost impossiible to obtain information from them. Those whose purpose it is to promote the establishment of an iron and steel industry on the Pacific Coast, such as Chambers of Commerce and similar organizations, are prone to be too enthusiastic. Their quantities are usually several times too large. On the other hand, the iron and steel corporations, when asked to establish such an industry, will quote statistics that are much more conservative, perhaps more nearly representative of the conditions, but undoubtedly on the smaller side of the scale. However, in this discussion the important factor is not so much what the present consumption is but what the consumption would be if cheaper iron and steel were available.

No pig-iron is produced on the Pacific Coast. Most of that used comes by rail from the East. Small amounts arrive from time to time from China and occasionally from Great Britain and elsewhere. Two hundred tons of pig-iron is consumed daily, practically all of it being used for making gray-iron castings. With cheaper pig-iron the present output of castings will be increased, and thus the market for foundry iron will become larger.

The production of steel in California, Oregon, Washington, and Utah is 1000 tons per day. Scrap-iron and scrap-steel are used almost entirely because they are cheaper than pig-iron. Cheap pig-iron would replace a large portion of this scrap. The steel-makers would like to use part pig-iron in the charges to the furnaces because at times scrap is hard to get, its cost increases with the demand, and a mixture of part scrap and part pig-iron is more desirable from the standpoint of melting.

Although the total consumption of steel on the Coast is large, it consists of many different sizes and shapes, without a large continuous consumption of any one. Steel rolling-mills are complex and expensive and to be operated profitably must have a large production. It would be impossible to construct and operate a mill to produce so large an assortment of sizes and shapes on the small scale necessary to prevent flooding the Pacific Coast market. Those products must be made for which there is a large steady demand or which can be made by the same machinery. An example of a product for which there is sufficient demand to take the output of a modern rolling-mill is tin-plate. The consumption of tin-plate and tin-cans in California, Oregon, Washington, British Columbia, and Alaska amounts to 150 tons daily, and the amount exported through Pacific ports to 100 tons. Hence, a market exists for 250 tons daily, and it is reasonable to suppose that a portion of this market could be absorbed by a producer on this coast.

The market for steel products will grow as the West grows; each will help the other. At the present time, however, there is little opportunity for the development of a large steel industry. The development to be anticipated will come through the slow and substantial growth of the present producers, increasing their output and developing new products (such as tin-plate) for which there is a sufficient market.

Pig-iron produced on the Coast, if cheap enough, will be used by the foundries for making gray-iron castings and by the steel works as a partial substitute for scrap-iron and scrap-steel. The amount of pig-iron that will be consumed will depend upon its cost. There is sufficient outlet through these two sources for the output of one blast-furnace of about 400 tons capacity. A cheap source of pig-iron once established, new industries will spring up, consumption of iron castings and steel products will increase, and thus a larger production of pig-iron will gradually become possible.

Japan is expanding her steel industry rapidly. Not sufficient ore is found in Japan, so ore and pig-iron are being brought to Japan from China. The production of iron and steel is now between 550,000 and 750,000 tons per annum. The consumption is between 1,500,000 and 2,000,000 tons per annum. Japan, therefore, will be an importer of American iron and steel products for some time. However, her industry is expanding so rapidly that the time is coming when she will be able to take care of herself. Whether this expansion will become great enough for Japan to export to American and therefore compete in the Pacific Coast States is questionable.

Much has been said in the past regarding the importation to this country of cheap Chinese pig-iron. It is true, Chinese pig-iron has been laid down on the Pacific Coast, for less than pig-iron from eastern United States could be. But there is no danger of any great competion from this source. The so-called cheap Chinese labor is not cheap when reduced to terms of output per dollar. Coke is available in China, but it is expensive. Considering all things, the cost of producing pig-iron in China is comparatively high; and China, rather than engaging in the production and exportation of iron, will become an active consumer, particularly of steel products.

Another factor entering into a discussion of markets is the attitude of the Eastern producer. In order to held his present market on the Pacific Coast, he will fight any competitor on the Coast by cutting costs. On some products it is likely that the reduced cost will be comparable with the cost of production on the Coast. This, of course, would reduce the possible output and make the project still more precarious.

Smelting Process. The size and type of smelting operation depends upon the size and the nature of the market. If there is a large enough outlet for pig-iron, the blast-furnace process will be used, because it is the standard, and, of course, the cheapest. The high cost of coke and the fact that the market for pig-iron extends over the vast area of the Pacific Coast States may make the cost of production of iron so large that the present margin due to the high cost of transportation will be eliminated.

Statements have been made by engineers that pig-iron can be made as cheaply on this Coast as in the East. C. C. Jones of Los Angeles showed by calculation that this could be done by bringing coke into southern California from Utah. Others have suggested that this could be done in a plant in the Puget Sound region using Pierce County coke. The determination of the cost of production is a difficult problem. It can be done best by ex-

perimentation. This would be costly and should be attempted only by those with the true pioneering spirit and with sufficient financial backing to be able to withstand great losses. In the beginning, costs of operation will be high, and unforeseen difficulties will arise. Absence of profit during the early days of operation must be anticipated. The most advantageous site for the plant is in the Puget Sound district.

Electric smelting has been suggested as a substitute for the blast-furnace for the following reasons: (1) Good coke is not essential and the quantity of fuel needed amounts to only one third that needed in the blast furnace; (2) small-scale production is possible; (3) there is cheap power, or at least cheap potential power along the Coast. Were all these reasons facts, electric smelting would be a possible substitute. But power is not cheap, at least from the standpoint of electric pig-iron, and will not be cheap for many years to come.

Another process has been proposed, a substitute for both the blast-furnace and the electric-furnace processes and a sort of combination of the two. It is the preparation and melting of sponge iron. Briefly, the process consists of grinding and purifying the ore by magnetic concentration, mixing it with a low-grade fuel, heating for two or three hours at a temperature of about 950 deg. C., cooling, and passing the mixture through a magnetite separator. Metallic iron in a very finely divided condition, free from impurities, is obtained in the concentrate. This product is called sponge-iron. It is then melted in the presence of carbon in an electric furnace, by which means various grades of iron and steel can be made at will. From a theoretical standpoint, this process has some promise. It will utilize fuel of poor quality and can be used with impure ores. The fact that various grades of iron and steel can be made makes it adaptable to the conditions existing on the Pacific Coast. For example, to large centres that have near them deposits of iron ore and cheap fuel and that consume both foundry iron and steel ingots, this process would be peculiarly adapted. Sufficient experimentation has not been done to point to either success or failure.

Conclusion. The establishment of an iron and steel industry must not be undertaken without due consideration of all the relating factors. We need cheaper iron and steel; we have the raw materials at hand; we have only to determine the cost of production. The cost of production will depend upon the cost of coke, the size of the market, and, hence, the size of the metallurgical operation. The size of the market will depend upon the cheapness of the pig iron and upon the number of different steel products that can be made profitably in the rolling mill. The presence of such an industry will stimulate the growth and development of the West. The determination of the cost of production can, and undoubtedly will, soon be made, but it must be done by a strong organization and one with a fund of advice, both technical and commercial.

Dr. G. A. Young of the Geological Survey is at Moose Factory on his way to the Belcher Islands. According to reports reaching Toronto, Dr. Young has been delayed by loss of his equipment when a sailing vessel on which he was a passenger struck a reef on its way from Albany to Moose Factory. Eighteen persons on the boat all reached shore safely; but instruments and supplies suffered and will have to be replaced before the expedition leaves for the Belcher Islands.

Iron Ore in Alberta

(From 2nd Report on the Mineral Resources of Alberta by Dr. John A. Allan.)

Lower Mackenzie Basin.

Occurrences of iron ore in the Lower Mackenzie River valley have been noted by Dr. E. M. Kindle in 1919.

The most northerly occurrence which Dr. Kindle observed is represented by thin bands of limonite, less than ten inches thick, in shales of Cretaceous age which outcrop along a large stream entering the Mackenzie five miles above the ramparts and thirty miles south of the Arctic Circle.

A one-foot band of limonite near the top of Silurian reddish gypsum-bearing shale is also noted as occurring on the southern slope of Bear mountain near Fort Norman. A bed of lignite coal of fair quality occurs within three miles of Bear mountain. A five-foot bed of lignite coal is exposed in the bank of the Mackenzie at Fort Norman.

Kindle states that the most promising bed of iron ore known in the Mackenzie valley is a twenty-foot band of hematite which outcrops twenty miles east of the river, on the eastern escarpment of a mountain range that represents the eastern face of the Franklin mountains. "The thickness of the ore and its relations to the beds in which it occurs are shown in the following section, measured in descending order, on the eastern slope of Cap mountain near the eastern end of an Indian trail that leaves the Mackenzie at the mouth of a ravine about one mile north of Wrigley. The total thickness of this section is in the neighborhood of 5,000 feet, but only the part exposed in the eastern face of the mountain is given here.

Red quartzite and sandstone (summit of mountain) Dip 10 to 15 degrees to west	500
Red shale and ferruginous sandstone	50
Hematite	20
Red sandstone with high percentage of iron	50
Dark shales	150
Greyish to drab shale	225

"Average samples collected from each of four different levels in the bed indicate a rather siliceous ore too low in iron to be commercially valuable at the present time. A composite sample made from equal weights of these four samples was found on analysis to contain metallic iron, 12 per cent. A selected sample collected by Mr. Joseph Hodgson of Fort Wrigley gave the following analysis:

Iron metallic	56.01	per cent
Silica	15.42	per cent
Sulphur	0.014	per cent
Phosphorus	0.031	per cent

"Five or six hundred feet of horizontal exposure of this ore was examined and showed no noticeable variation in thickness. Though this bed of ore has not been seen in any other sections, its considerable thickness apparently justifies the expectation of a rather extended distribution in a north and south direction, which is the direction of its line of probable outcrop."

The hematite ore on Mount Cap is placed in the Upper Silurian series.

A sample of shaly hematite analyzed by J. A. Kelso at the University of Alberta gave:

Insoluble siliceous residue	66.42 per cent
Oxide of iron	26.44 per cent
Oxide of aluminum	4.38 per cent
Lime	.00 per cent
Magnesia	.00 per cent
Loss on ignition	2.08 per cent
Equivalent of oxide of iron as metallic iron	18.49 per cent

If this sample is representative of the body of the deposit the high silica content and low iron would not make this deposit a commercial ore. Keele in 1910 reports an occurrence of hematite 50 to 100 feet thick coarsely laminated with red siliceous slates about 100 miles west of the Mackenzie on the Gravel river which enters the Mackenzie four miles above Fort Norman. "An assay of an average sample of this ore was made at the assay office of the Mines Branch, and gave only 25 per cent of iron."

Sheep River Deposits.

The occurrence of iron along the Sheep river outside the mountain was discussed in detail in the "First Annual Report on the Mineral Resources of Alberta," page 65. In that report I stated in referring to the deposits on the south fork of Sheep river near the junction of Maccabee creek, that although a report had been circulated that this deposit contained 2,400,000 tons of iron ore analyzing 29.9 per cent metallic iron, I had not found up to that time "a single ton of rock exposed in that section that could be classed as iron ore. This report has been criticized severely, and it has been stated that the real deposit of iron was not examined. In order to verify my statement interested parties forward on two samples from this deposit for analysis. One sample contained less than 1.05 per cent oxide of iron, which represents about 1 per cent metallic iron. The other sample of ironstone nodule gave 4.75 per cent iron oxide, which represents about 3 per cent metallic iron. Analyses of samples which I collected and which are included on page 66, First Annual Report, 1919, showed 4.55 per cent metallic iron in one and 4.03 per cent in the other. These analyses are considerably lower in iron content than those made from samples which I collected in 1919. These results emphasize my statement that the iron content in this formation is low and the deposit is of no economic importance. It is unfortunate that even yet attempts are being made to interest the public in this unimportant occurrence of iron oxide.

During the past summer further field investigations were made of the Benton shales, in which the iron is supposed to occur along Sheep river and Highwood river. Benton shales are exposed at a number of points where the river cuts transversely through the formation. Particularly good exposures are to be seen along Sullivan creek between the bridge and the point where it enters the Highwood. These shales are slightly ferruginous and contain clay ironstone bands similar to those on Sheep river, but even in this section, there can be no beds which can be considered as economic deposits.

Production of Iron Steel in Canada During May 1920

(Abstract of Monthly Report of Dominion Bureau of Statistics.)

Pig-Iron and Ferro-Alloys.

The May production of pig iron and ferro-alloys in Canada showed an advance of more than 43 per cent over the April output, production rising from 39,693 long tons in April to 57,035 tons in May. Basic iron output was nearly trebled, the total for this item being 44,002 tons compared with 15,9791 tons in April. Of this amount, 43,972 tons was reported as made by firms for their own further use in processes of manufacture, only 30 tons being made for direct sale as such.

Foundry iron, which showed up so favorably in the March and April reports slumped in May to 9,915 tons, or less than half the amount produced in the preceding month when 22,929 tons was made. Of the May production, slightly more than half was made by firms for their own use, the amount credited to this item being 5,206 tons. The remainder, 4,709 tons was made for sale, Malleable iron output was restored in May to 2,162 tons, none was produced in the preceding month.

Ferro-alloys production rose slightly in May to 944 tons, from a total of 793 tons in April. The production as in April consisted entirely of ferro-silicon, in grades from 17 per cent to 50 per cent. Electro Metals, Ltd., Welland, make 50 per cent ferro-silicon and two other firms, the Abrasive Company of Canada, Ltd., Hamilton, and Canadian Carborundum Co., Ltd., Niagara Falls, produce ferro-silicon as a by-product in the manufacture of artificial abrasives. All three firms reported production in May.

Only five blast furnaces were active at the end of May, leaving fifteen idle, a net loss for the month of one furnace. Four furnaces were operating in Ontario at the close of the month; three at Sault Ste. Marie, and one at Hamilton. The Dominion Steel Corporation continued with one furnace in blast at Sydney, C. B.

Steel Ingots and Castings.

Nearly twice as much steel was made in May as during April; the tonnages of steel ingots and castings produced being reported as 52,001 long tons in May compared with 27,381 tons in the preceding month. Basic open hearth steel led the list, rising from 25,252 tons in April, to 49,884 tons in May, the entire production in both months being made by producers for further use in their own plants.

A total of 132 tons of acid open hearth steel was also made during the month, but very little of this steel is made in Canada as the record for the year to date shows only 239 tons made in all during the five months' period. The production of steel castings remained practically the same, at 1,933 tons compared with 1,938 tons in the previous month. Of this amount, 1,738 tons was made from electric furnaces and 1,592 tons was produced for direct sale. Small quantities of basic and acid open hearth steel castings were made together with slightly more than one hundred tons of castings by the converter process.

The average monthly production of pig-iron and steel

in Canada is calculated annually since 1907 to have been as follows:

	Long Tons	
	Pig Iron	Steel Ingots & Castings.
1907	18,000	53,000
1908	17,000	44,000
1909	36,000	56,000
1910	60,000	61,000
1911	68,000	66,000
1912	69,000	71,000
1913	84,000	87,000
1914	58,000	62,000
1915	68,000	76,000
1916	87,000	106,000
1917	87,000	130,000
1918	89,000	140,000
1919	68,000	77,000
1920	81,000	92,000
1921 5 months	51,000	46,000

The May figures for pig-iron were 57,000 tons and for steel 52,000 tons. Pig-iron production during June and July will not show much change from the outputs of May, but steel production should show an increase, as much cold stock has been used up. Stocks of iron-ore and fluxes on hand are unusually large. No Canadian production of iron ore is reported in 1921, and none is likely to be.

The comparison between pig-iron production and steel output shown above indicates much importation of pig-iron when steel demand is large. It also indicates that the enlargement of Canadian steel output has not been accompanied by any real enlargement of blast furnace capacity in the Dominion.

B. E. STEEL STAFF APPOINTMENTS.

D. H. McDougall, Vice-President of British Empire Steel Corporation, announced under date of July 15th, appointment of George D. Macdougall, latterly General Superintendent of the Nova Scotia Steel & Coal Company, as Chief Engineer of the Corporation, and of A. McColl, for many years Secretary of the Nova Scotia Steel Company and Assistant to the President, as General Manager of the Nova Scotia Company, including the consolidated properties of the Corporation centred around New Glasgow.

Mr. Macdougall's experience has been of a nature to fit him exceptionally well for the wide and onerous duties that he will have to undertake as Chief Engineer of the Corporation, as these will extend over an area and will include a variety of engineering problems unique in Canadian corporate industrialism.

Mr. Macdougall, who was born in 1873 at St. Peter's, Cape Breton, graduated from McGill in 1895 with the degree of B.A.Sc. (with honours) in mechanical engineering, and the following account of his career following graduation is taken from "Institute Notabilities" series in the Bulletin of the C. I. M. & M. of June 1920.

"Beginning with the Robb Engineering Company of Amherst, N.S. Mr. Macdougall went across the line, and was engaged in shop and engineering work for the G. F. Blake Manufacturing Company, of East Cambridge, until 1898. For the next year he was chief draughtsman on marine engineering for the Fore River Ship & Engine Company, Weymouth, and later was in charge of power-house design and erection with the Edison Illuminating Company of Boston. In 1900 he went with the Dominion Iron & Steel Company as master mechanic and assistant manager of the ore-mines at Wabana, Newfoundland, but returned to the United States at the end of 1901 to become assistant chief engineer of the Lackawanna Steel Company, Buffalo, and later mechanical superintendent. From 1904 to 1909 he was with the Steel Company at Sydney, two years as mechanical superintendent and three as chief engineer, following which he was superintendent of construction for the Canada Iron Corporation at Midland, Ont. At the beginning of 1911 he returned to the Dominion Company as mechanical superintendent, and in 1916 became assistant general superintendent, retaining this position until in 1918 he became general superintendent of the Nova Scotia Steel Company."

Mr. Macdougall is President of the Mining Society of Nova Scotia, a vice-president of the Canadian Institute of Mining & Metallurgy, and a member of the Engineering Institute of Canada. He was also the first president of the Nova Scotia Accident Prevention Association, and is Grand Master of the Freemasons in Nova Scotia.

Mr. A. McColl's appointment comes naturally after a term of service with the Nova Scotia Steel Company, and its predecessors, that extends from his graduation from Dalhousie and Boston Tech. to the present date. He has seen the Scotia Company grow from the humblest beginnings, and has taken an active part in that development. The official statement in connection with Mr. McColl's appointment announces that he will have his headquarters in New Glasgow, and will direct the operations of the Steel Plant at Trenton, the Eastern Car Company and the Acadia Coal Company, and that, at a later date, the Springhill collieries, now managed from Glace Bay as a district of the Dominion Coal Company, will be attached to the New Glasgow management, thus consolidating all the mainland operations of the Corporation, which are not far apart and are physically very similar.

These appointments are in continuation of the policy of utilising the best executive material in the staffs of the consolidated companies, so as to restore former efficiency and give the Corporation the benefit of technical direction by specialists already trained in and acquainted with local conditions.

COAL OUTPUTS, B. E. STEEL CORPORATION, FIRST HALF 1921.

The coal production of the constituent companies of the British Empire Steel Corporation for the first half of 1921 compares with the two previous years as follows:

	(Long Tons)		
	1919	1920	1921
Dominion Coal Co.	1,727,018	1,825,439	1,634,903
Nova Scotia Coal ..	243,576	315,329	280,824
Acadia Coal	190,558	249,463	197,960
Total	2,161,152	2,390,231	2,113,687

From present market indications the production of the combined companies for 1921 may reach 4,250,000 tons, which will compare with 4,839,402 tons in 1920 and 4,439,360 tons in 1919. The combined production of the three companies in 1913 was 6,473,581 tons, and the 35 per cent reduction in coal output which recent years have shown from the 1913 figures is chiefly attributable to the drain of the war upon the man power at the collieries, and to the fact that this drain was concentrated upon the producing class of mineworkers.

Production of Steel in the United States

American Iron and Steel Institute's Figures.

Production of finished iron and steel rolled products in 1920, according to Americon Iron and Steel Institute, totaled 32,347,863 gross tons, breaking all records for peace years .

Over the 1919 output of 25,101,544 tons it shows a gain of 7,246,319 tons, or 28.9 per cent. The 1920 total was surpassed only in two war years, 1916 and 1917, in which production totaled 32,280,389 and 33,067,700 tons, respectively.

Expansion of American steel trade is shown by comparison of 1920 output with 1910, 1900 and 1890. Over 1910 output of 21,621,279 tons the 1920 figures show an increase of about 49.6 per cent, over 1900 productoin of 9,487,443 tons an increase of 235 per cent, and over 1890 totals of 6,022,875 tons, an increase of 437 per cent.

Total output of all rolled iron and steel products in the United States from 1887 to 1920 is as follows (gross tons):

1920	32,347,863	1903	13,207,697
1919	25,101,544	1902	13,944,116
1918	31,155,754	1901	12,349,327
1917	33,067,700	1900	9,487,443
1916	32,380,389	1899	10,294,419
1915	24,392,924	1898	8,513,370
1914	18,370,196	1897	7,001,728
1913	24,791,243	1896	5,515,841
1912	24,656,841	1895	6,189,574
1911	19,039,171	1894	4,642,211
1910	21,621,279	1893	4,975,685
1909	19,644,690	1892	6,165,814
1908	11,828,193	1891	5,390,963
1907	19,864,822	1890	6,022,875
1906	19,588,468	1889	5,236,928
1905	16,840,015	1888	4,617,349
1904	12,013,381	1887	5,235,706

In 1920 production of more important finished products was: Rails, 2,604,116 tons; plates and sheets, 9,337,680; wire rods, 3,136,907; structural shapes, 3,306,748; merchant bars, 6,130,240; reinforced bars, 572,445; skelp, flue, and pipe iron or steel, 3,220,289; rolled forging blooms, forging billets, etc., 447,334; blooms, billets, sheet bars, etc., for export, 136,457. Of total production 95.7 per cent was rolled from steel, compared with 95.8 per cent in 1919.

Plants which rolled finished steel products in 1920 aggregated 417 in 30 states and the Canal Zone, Panama, compared with 402 plants in 30 states in -9-9.

Following compares 1920 output of some leading iron and steel products with the last ten years, 1895, 1890 and 1887; in gross tons:

	Iron and steel rails	Plates and sheets	Wire rods	Structural shapes
1920	2,604,116	9,337,680	3,136,887	3,306,748
1919	2,203,843	7,372,814	2,538,476	2,614,036
1918	2,540,892	8,799,135	2,562,390	2,849,969
1917	2,944,161	8,267,616	3,137,138	3;110,000
1916	2,854,518	7,453,980	3,518,746	3,029,964
1915	2,204,203	6,077,694	3,095,907	2,437,003
1914	1,945,095	4,719,246	2,431,714	2,031,124
1913	3,502,780	5,751,037	2,464,807	3,004,972
1912	3,327,915	5,875,080	2,653,553	2,846,487
1911	2,822,790	4,488,049	2,450,453	1,912,367
1906	3,977,887	4,182,156	1,871,614	2,118,772
1900	2,385,682	1,794,528	846,291	815,161
1895	1,306,135	991,459	791,130	517,920
1890	1,885,307	809,981	457,099	
1887	2,139,640	603,355		

Production of miscellaneous iron and steel products, similar to output of finished rolled products, broke all records for peace years. Output of 3,218,177,730 pounds of tin plates and terne plates was exceeded in only 1917 and 1918, and 16,449,506 kegs of wire nails only in 1916 and 1917. Galvanized sheets, aggregating 2,015,255,681 pounds in 1920 ,broke all records.

Steel ingots and castings output totaled 42,132,934 tons, of which 40,881,392 tons were ingots and 1,251,542 castings. In 1920 there were 205 works in 24 states and the District of Columbia making steel ingots, against 198 works in 26 states and District of Columbia in 1919.

Following compares steel ingots and castings production from 1906 to 1920 inclusive (gross tons):

1920	42,132,934	1912	31,251,303
1919	34,671,232	1911	23,676,106
1918	44,462,432	1910	26,094,919
1917	45,060,607	1909	23,955,021
1916	42,773,680	1908	14,023,247
1915	32,151,036	1907	23,362,594
1914	23,513,030	1906	23,396,136
1913	31,300,874		

The Electric Furnace Company, Alliance, Ohio, reports more orders for its Baily Electric Furnaces in June than in any single month in the last two years. These orders include standard brass melting units, car furnaces for steel plant purposes, and a special electric enameling equipment. Most of the sales were made to concerns not particularly busy at the present time, but who purchased this equipment with a firm belief that by the time the furnaces were installed and ready for operation business would be such as to amply justify the present expenditure.

Indications point to an equally good month in July. The foundries are exhibiting a desire to modernize their equipment so as to lower their cost of production and meet competition when business again becomes normal.

One of these recent sales, to the Empire Manufacturing Company, Ltd., London, Ontario, marks the fifth Baily furnace sold in Canada during the past year. It is the second Baily furnace for this plant. It is rated at 105 K.W. and has a hearth capacity of 1,500-2,000 pounds.

The Mueller Metals Company, Decatur, Ill., has ordered three 105 K.W. Baily furnaces each with 1,500-2,000 pounds hearth capacity. The entire battery will be used for melting brass in their Decatur plant.

The Ingram Richardson Manufacturing Company, Beaver Falls, Pa., has awarded a contract for a 600 K.W. Baily Electric Enameling furnace. This is to be a rotating car type furnace arranged to travel on a circular platform 60' in diameter. The equipment will have a heating capacity of 44 tons of material per day.

THE ACCIDENT PREVENTION CAMPAIGN OF THE ALGOMA STEEL COMPANY.

An Effort Amply Justified by Results.

The application of publicity to the solution of the industrial accident problem is the key note of the safety campaign which has been going on in the plant of the Algoma Steel Corporation at Sault Ste. Marie, Ontario, since the 1st. of October last. As a net result, the campaign has been pronounced a success by the General Manager and is being kept up. Thus far there has been a diminution of some 50 per cent in the number of accidents, over 70 per cent in the monthly amount of time lost (this showing a decrease of the percentage in the severity of accidents). Exact figures are not as yet available as to the decrease in the amount of compensation payable but it is estimated to be of about the same percentage as the decrease in severity.

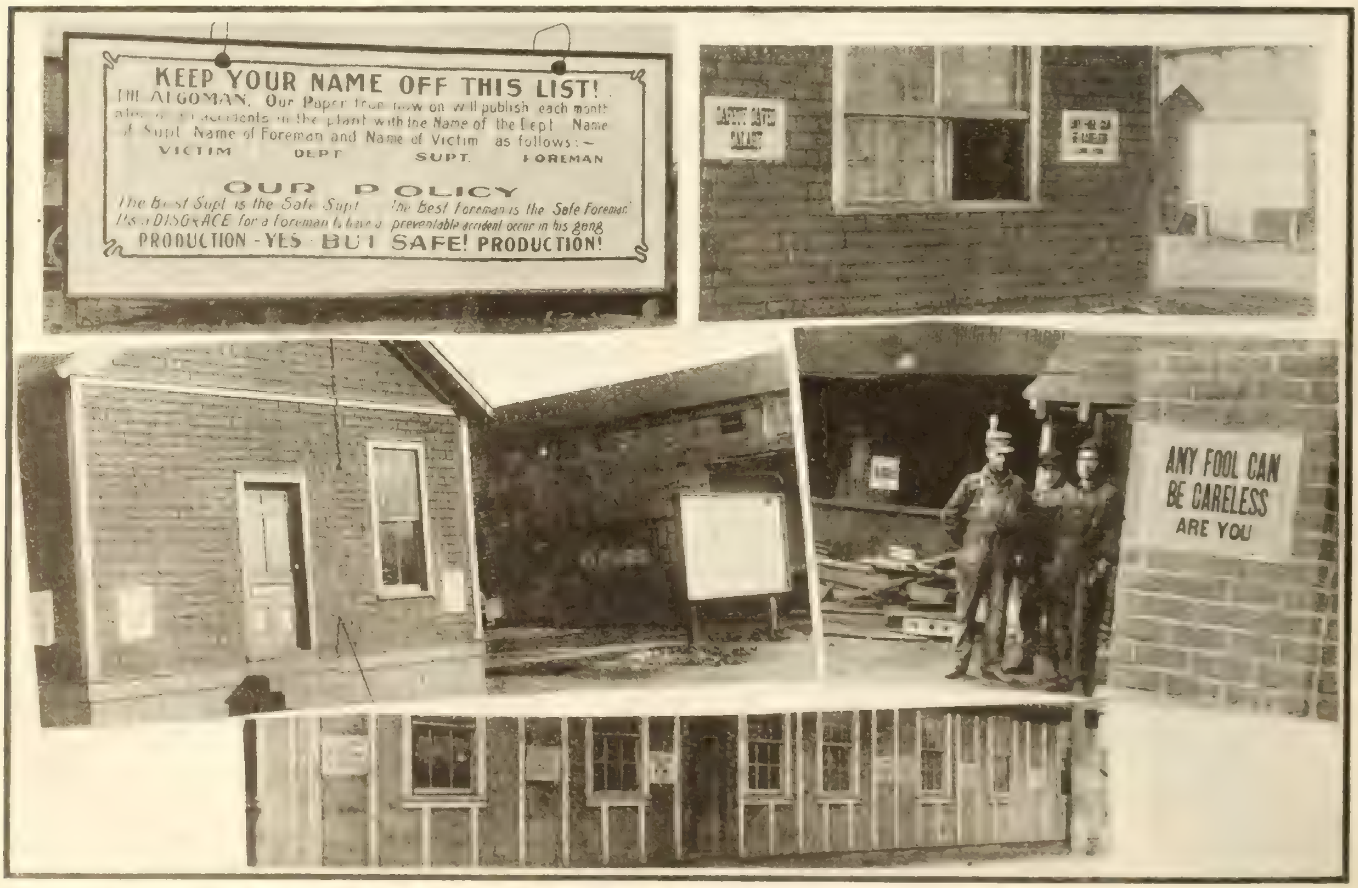
The theory underlying the whole campaign is that the personal element is responsible for over 95 per cent of all accidents. Hence, the problem is attacked by educating the human machine. In this education reliance is placed absolutely upon the psychological power of the printed word in all its forms — in other words the pulling power of publicity. Use is made of this power to inculcate lessons on safety, the whole to the general effect that thoughtlessness is the cause of carelessness, which, either directly or indirectly, is the cause of all accidents; that neither men nor machines are designed to make or cause accidents; that if men or machines do cause accidents it is because they go out of the beaten track of what they are designed or intended to do; that every accident denotes something wrong with men, methods or materials — but especially with men; because if materials are wrong or methods are wrong it is because men made them so or allowed them to remain so. These safety truths were embodied in pithy forms in thousands of posters distributed or posted all over the plant, huge bulletin boards were erected and a house organ, "The Algoman", was founded, with safety as sole plank of propaganda.

The Safety Department was thoroughly reorganized and a system of mill inspection, as well as accident investigation, instituted. Every unsafe place in the mill, in so far as possible, was guarded; every accident, no matter how small, was investigated by safety inspectors and a written report made thereon, careful note being taken as to the cause of the accident, whether the carelessness of the victim or someone else, faultiness of the machinery, of the methods of operation, etc.

In every case where pure carelessness was shown to be the cause of the accident, disciplinary methods were adopted.

Throughout the plant and in the columns of the house organ stress was laid upon the fact that safety was a live issue; that the best Superintendent was the safe Superintendent; that the best foreman was the safe foreman and that it was a disgrace to any Superintendent or foreman to have a preventable accident occur amongst his men. Moreover, in the colums of "The Algoman", published monthly, a list of every accident was made, giving the name of the victim, the name of the superintendent, the name of the department and the name of the foreman. This had the effect of jacking up everybody by making it a matter of intimate personal interest to him, to avoid accidents.

In order to keep the accident situation constantly before the eyes of everybody in the plant from day to day, huge indicator boards, with sliding thermometric indi-

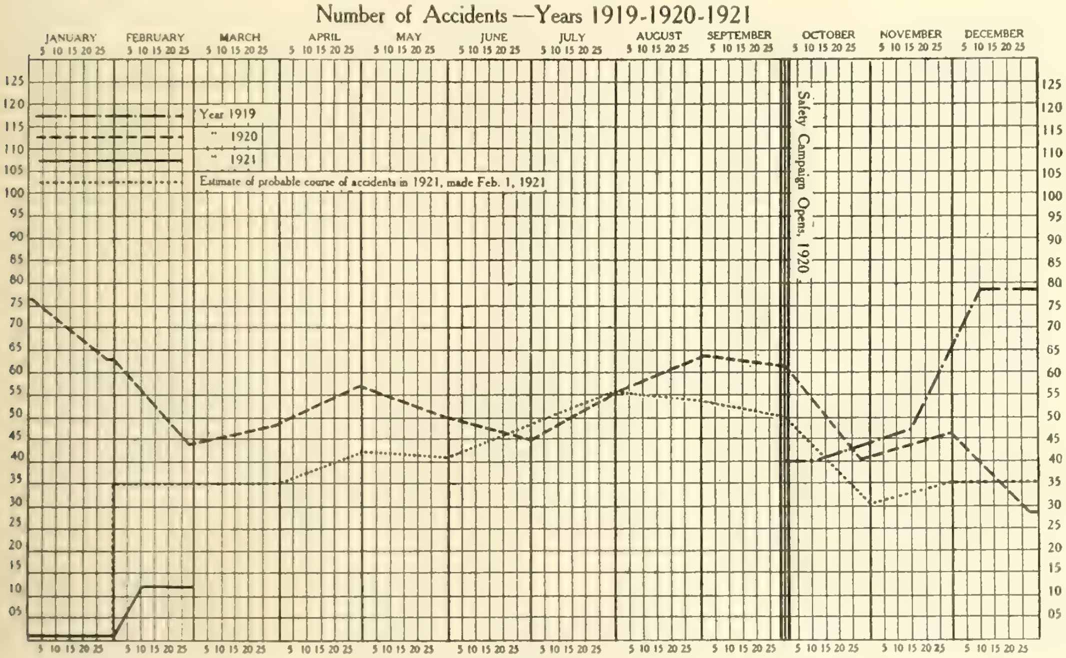


Examples of "Safety First" Publicity at the Plant of the Algoma Steel Corporation Saulte Ste. Marie.

cators, were erected at every gate in such a position that every man, passing in or out, necessarily saw the exact standing from day to day, each day of the month. These indicator boards were so arranged as to give a comparative view of the situation each day on the same day of the previous month. The theory underlying the erection of these boards was to have everybody in the plant so made to think "Safety" at all times, that everybody would be more inclined to be careful; and everybody being more careful, there would, of necessity, be a reduction in the number of accidents. The experience of the Algoma Steel Corporation would seem to have shown this theory to be correct.

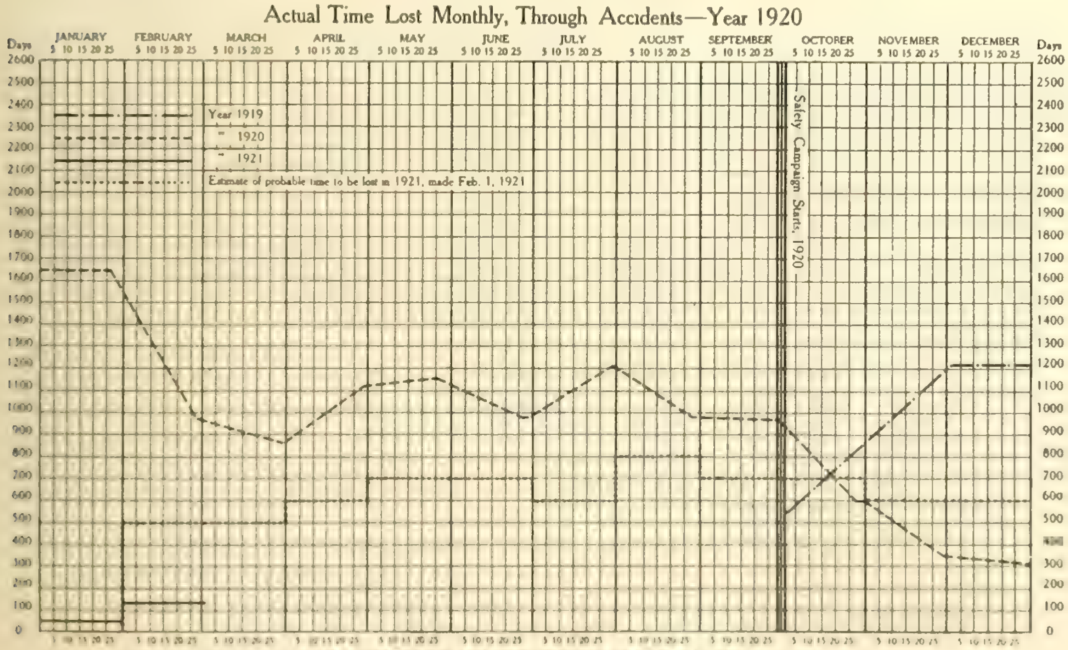
In addition to the inspection of mills and the investigation of accidents, the system in the Medical Office maintained at the plant was also reorganized in such a way that the Safety Department was placed in possession of a daily report, in writing, showing the number of dressings made on the previous day, the condition of each patient, nature of injury, progress from day to day, with special report in each case on the first, third and sixth day following the accident. These medical reports are filed away together with the accident investigation reports in every case, no matter how slight the accident, no matter whether the victim be off work for one day or one hundred days. Every case is fully accounted for, so that if, at any future time, demand is made for information regarding any accident case in the plant, whether such demand be made by the Compensation Board or any other interested party, the Corporation is in full possession of all the facts in each case. The advantage of this is that in the case of claims arising subsequently after a lapse of weeks or months, following an alleged accident, full details of this accident (if there was an accident at all) are available, with the name of witnesses, testimony of witnesses, the exact place where accidents occurred, the exact time, how it occurred and whether the victim was attended

Number of Accidents—Years 1919-1920-1921



P.S.—FIGURES FOR 1921, AS THEY STOOD ON MARCH 1st 1921

Actual Time Lost Monthly, Through Accidents—Year 1920



P.S.—FIGURES FOR 1921, AS THEY STOOD ON MARCH 1st 1921

Curves showing Reduction of Number of Accidents, and of Time lost through Accidents.

Algoma Steel Corporation.

by a physician and, if so, what the physician's finding was, etc.

The campaign has been directed by Mr. Frank J. McGee, Superintendent of Industrial Services and Director of Safety. Mr. McGee is a graduate in arts and economics, and formerly a newspaper man, and he has been given a free hand in arousing the interest of the workmen in accident prevention. Every Algoma Steel Company's man is now a "booster" for the safety idea, and the results obtained are the best justification of the effort put forth.

UNITED STATES PRODUCTION OF FLUORSPAR IN 1920.

The total quantity of fluorspar reported as shipped from domestic mines in 1920 according to figures compiled by Hubert W. Davis, of the United States Geological Survey, was 18,778 short tons, valued at $4,-718,547, which shows an increase of 35 per cent in value as compared with the figures for 1919. The general average price per ton f.o.b. mines or shipping points for all grades of spar in 1920 was $25.26; in 1919 it was $25.49.

The total quantity of merchantable spar recovered in 1920 was 201,372 short tons, an increase of 31 per cent over 1919.

Stocks of spar at mines or shipping points, mainly in Illinois and Kentucky, amounted to 41,784 short tons, an increase of 31 per cent over 1919.

Imports and Exports.

The imports of fluorspar into the United States in 1920 were 24,612 short tons, valued at $265,630, an increase over 1919 of 254 per cent in quantity and of 147 per cent in quantity and of 147 per cent in value. Of the imports England supplied 69 per cent, Canada 29 per cent, Germany 1.6 per cent, and Australia and British South Africa supplied small quantities.

The exports of fluorspar from the United States Geological Survey by the producers, amounted to 2,764 short tons, valued at $65,475. All the fluorspar exported was sent to Canada.

The imports of fluorspar during the first four months of 1921, the greater part of which was brought from Canada, amounted to 4,049 short tons, valued at 339,990. The figures showing the imports were compiled from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

Consumption and Stocks.

Figures furnished by steel manufacturers who produce about 75 per cent of the output of basic open-hearth steel show that the steel industry consumed about 117,000 short tons of fluorspar in 1920 and that the stocks of spar on hand January 1, 1921, at all steel plants were about 66,600 short tons. From January 1 to April 30, 1921, about 22,600 tons of spar was consumed by basic open-hearth steel plants. Figures showing the shipments of domestic fluorspar to steel plants during this four months period are not available, but the total was evidently small, and of the 4,000 tons imported practically all has been taken by steel manufacturers.

THE CANADA METAL COMPANY, LTD.

By A. R. R. JONES.

A veritable model of construction and equipment is the factory of the Canada Metal Company, Ltd., on Fraser Avenue Toronto. It takes more than determination, more than capital, more than agressive salesmanship — it takes *Quality* in its products — to achieve the position that this Company has attained in the industrial life of the Dominion. It is quality that has been predominant in the manufactures of this concern ever since it has been in business. It is now, by the way, some thirty-five years since it was started, in quite a modest way by Mr. W. G. Harris, Senior, the president of the Company, on William Street, Toronto.

Owing to the high standard of quality which it placed before itself at the very outset of its career, and to which it has, ever since, staunchly and steadfastly adhered, the business grew with considerable rapidity. About ten years ago, the Company felt the necessity of acquiring larger grounds and improved shipping facilities. These it was fortunate enough to acquire on Fraser Avenue, Toronto,—truly an ideal site for a plant of this nature—and here it built a magnificent plant, as modern in construction and as efficient in equipment as could possibly be desired. From time to time the plant has been added to as necessity has arisen, until to-day the buildings cover an area of six acres in extent.

Its Alert "Alive" Atmosphere.

In addition to the Toronto plant, the Company has plants at Vancouver, Winnipeg and Montreal. But, the parent plant, that at Toronto is the largest of all. The officers of the Company, in addition to the president, Mr. G. W. Harris, Senior, are Messrs, W. G. Harris, Junior, vice-president and manager; G. H. Anderson, secretary and H. C. Crow, Sales Manager. The president, Mr. W. G. Harris, Senior, was good enough himself to show the writer all over the plant, a short description of which, as it is, in its own particular lines of manufacture, a model of what a plant of this nature should be may not be without some considerable interest. Before treating in any detail, however, of the plant and its various departments, a word should be said about the executive offices. These are unusually commodious and up-to-date in every way, and it is obvious that they are at once the source and the centre of that alertness and "aliveness" which are characteristic of the undertaking and of its every department.

As one enters the main door of the building, one arrives at the show room which contains samples of the Company's various products. The principal of these products are lead pipe—it should be mentioned that the company has the largest lead-pipe plant in the Dominion—Babbin-metals, as to which something will be said a little later on, zinc, solder, ingot-metals, sheet-lead, bronze-castings, lead-foil, plumbers' supplies and closet-tanks and accessories. From the show-room one proceeds to the well-equipped laboratory which is complete in every detail for the proper determination of the different metals required in the manufacture of the various products of the plant. This laboratory, in charge of skilled metallurgical chemists, puts beyond the pale of chance any inconsistency in the high quality of the alloys. Leaving the laboratory, one comes to the supply department which contains complete supplies

for plumbers. Here one finds everything for the plumber — baths, lavatories, sinks, "Aristocrat" laundry-tubs, lead-pipe, solder, block-lead, sheet-lead and so forth.

Lead-Pipe And Babbitt Departments.

Next one visits the lead-pipe department. Here all sizes of lead pipe are manufactured, from one-eighth of an inch to twelve inches in diameter. Numerous presses are used in the process, one of them making a length of pipe twelve inches in diameter and twelve feet in length, which weighs approximately 600 lbs. Here, too, are made wire solders of various grades and sizes, from No. 8 gauge to the finer size up to No. 21 gauge, as well as a great variety of lead-drawn articles.

Of very special interest is the Babbitt metal, type and solder department. This is splendidly equipped, the firm having the very highest reputation for the manufacture of Babbitt metal for every purpose. Some of the kettles or monster melting-pots have a capacity of thirty-five tons each and in one of these a car-load lot can be put through at one time. Thirty-five tons of molten metal boiling and bubbing, is a highly impressive sight. Indeed, the whole process of manufacture is educational as well as interesting, and is one calculated to leave a lasting impression.

Among the varieties of Babbitt manufactured in this department may be mentioned the following: "Imperial Genuine", for heavy engine and extraordinarily hard work, and containing no lead; "Imperial Tough", which is for thin bearings, will not crack or break in the bearing, contains no lead, and is suitable for automobiles, gasoline engines and light, rapidly-running machinery, and also for best-grade piston metal-packing; "Armature Special", a metal specially manufactured for heavy, street-railway armature linings; "White Brass", a very plastic metal, which will stand very high temperatures, and is specially adapted for ship machinery; "Metallic Genuine", which is suitable for heavy pressure work; "Harris Heavy Pressure", a metal designed and perfected by the president of the Company for the express purpose of overcoming the trouble of soft bearings that squeeze out, and of hard bearings that crack in the box of cut the shaft, and is a metal suitable for all classes of machinery: "Hercules Genuine", a very strong metal suitable for heavy machinery, and friction clutches; "White Bronze," a strong, hard, durable metal, made heavily graphited; "Star Frictionless", a medium-priced metal, for use where the higher grades are not required; and "Aluminoid", a metal much in use on all light machine work.

The Manufacture Of Sheet Lead.

The next point visited was the brass foundry which has a thoroughly adequate and up-to-date installation of some fifteen furnaces, oil-fired. This brass foundry is complete in every respect and is provided with squeezers and cranes for handling large work. From the brass foundry one goes to the tinning and re-tinning department which forms a very large unit. Here copper sheets are tinned and re-tinned, and the apparatus for this process is singularly complete. Next, there is the smelting department where cupolas and reberbatory furnaces reclaim, smelt and refine ores and metals.

From this last-mentioned department, one enters that devoted to the manufacture of sheet lead, where the largest mill in Canada turns out sheets of lead from 8 ft. 3 ins. wide and 50 ft. or more, as required, in length. It may be mentioned that, at one time, all sheet-lead used in Canada used to be imported from England. But now, owing to developments such as that which we are considering, all chemical or ordinary sheet-lead used in this country is Canadian-made. The process of manufacturing sheet-lead is one of great interest. First, the pig-lead is taken to the huge melting-pots, and when thoroughly melted, and alloyed, if antimonial sheet-lead is required, the molten metal is poured into huge moulds and forms slabs of lead 3½ inches in thickness. When sufficiently cool, these large slabs are transferred to the rolls, and the process of rolling into sheets is commenced.

Some Other Important Departments.

A recent development on the part of the Company is the foil department, where thin lead, tin and Britannia metal are rolled into foil a thousandth part of an inch in thickness and to any width desired. This foil is used for electrical work, and for covering cheese, tobacco, chewing gum and so forth. Britannia metal, florists' foils and electrotypers' lead are also made in this department.

Mention should not be omitted of the "Imperial" linotype metal which is made in this plant and which is very widely used in newspaper offices throughout the country. This is built especially for the linotype machine, and a strict adherence to the Company's formulae and process of manufacture tested by time, as both have been, assures to it unchanging physical properties.

The Company makes a very fine laundry tub known as the "Aristocrat" which embodies several special features designed to make it worthy of its name. Recently, too, it has turned its attention to the manufacture of closet tanks. For some years, the need of a closet tank that should be at once silent and efficient had been felt. To manufacture such a closet tank the Company established a very admirable plant, and already the output of its product—known as the "Pussyfoot"—exceeds 100 per day, although the line has only been established this year.

The Graham Nail Works is also owned and operated by the Company. In this department, several hundred kegs of nails—each keg containing 100 lbs—are turned out every day. These nails are of all sizes—from the very largest, twelve inches long, to the smaller sizes, half an inch or less. Various other products of steel wire are made in this department, including bale ties, bright wires, soft wire, tinned and coppered wire, and many other specialties.

The High Shot Tower.

One of the outstanding features—outstanding in more than one sense of the term—of this big plant is the lofty shot-tower from which are cast all sizes of shot. This tower is 150 feet high, and from it the shot are dropped, being cooled in their flight through the air, into water, the water preventing them from melting. The shot made here are of all sizes, from dust size to ball. This tower and the elevator which takes one to its summit cost some $20,000. The writer was taken to the top of this tower by Mr. Harris, Senior, and was greatly impressed (as nobody could fail to be) with the exceedingly fine view of the city of Toronto that is obtained therefrom. The tower immediately overlooks the Canadian National Exhibition grounds.

The tool room and machine shop are exceedingly well equipped and are operated by highly-skilled mechanics.

The employees at the Toronto plant number around 600. At present the plant is working to about eighty per cent. capacity. It should be added that the shipping facilities, with three lines of track entering the buildings, are all that could be desired.

What Is Wrong With Cost Accounting?*

Attention has often been drawn by accountants and others to the failure of a large percentage of manufacturers to adopt the methods of cost accounting approved by the majority of professional accountants, but as far as the writer knows these criticisms invariably have been directed at the manufacturer and not at cost methods themselves. It does not seem to have occurred to these critics that if a large body of intelligent and practical men consistently refuse to introduce the recognized methods of cost accounting, this refusal may be due not to a lack of progressiveness but to a deliberate judgment that the advantages to be gained from these methods are not of sufficient value to offset the expense of their acquirement.

That the failure of many manufacturers to introduce complete systems of cost accounting along the lines approved by the accounting profession is due to design rather than negligence would seem to be a reasonable supposition, for in general the average manufacturer is willing enough to spend money for innovations if he is fairly well satisfied that he will obtain an adequate return from his investment. In many cases he has cautiously waited to see the result of cost experiments in a neighbouring factory and often after noting the considerable number of clerks required to maintain the new cost system has concluded that it would have to be a very remarkable system indeed to produce savings sufficient to offset the resultant increase in the payroll. He usually decides, therefore, to spend his money on something from which he is more certain of receiving a substantial return.

The Purpose of Business.

Accountants are liable to overlook the fact that a manufacturer is in business for the primary purpose of making money, and as a matter of fact the advocate of the usual systems of cost accounting would have difficulty in proving to a manufacturer that expenditure in a cost system would, without question, turn out to be a profitable investment. He may urge, for instance, that by obtaining information as to which lines are profitable and which unprofitable the manufacturer will be able to keep the cream of the business for himself and leave the skimmed milk to his competitors, forgetting that it may be necessary for the manufacturer to carry a complete line in order to satisfy the requirements of his customers. The accountant may enlarge on the value of cost information as a basis for setting prices, but may be met with the statement that competition requires the manufacturer to meet prices regardless of what the records show his costs to be.

The Defects of Present Methods of Accounting.

Perhaps the best indication that there is something wrong with the usual methods of cost accounting is the fact that many large concerns whose cost methods are strictly in accordance with those advocated in standard works on the subject are beginning seriously to question whether these methods meet the requirements which should be demanded of a cost system. Recently the writer was present at a discussion between the general works manager and the chief cost accountant of a machine manufacturing concern whose name is a household word and whose cost methods would be regarded by many professional accountant as the acme of perfection. The cost system maintained by the concern in question provides accurate monthly information as to the cost of every part, assembly, and machine manufactured, and as to the profit and loss made on each kind of machine sold during the month; and yet the general works manager was so dissatisfied with the results obtained that he was considering the adoption of a subsidiary cost system entirely independent of the official cost system maintained by the accounting division.

In a discussion with his chief cost accountant he expressed himself very strongly as to the lack of practical value in detailed cost data presented fifteen days after the end of the month; he drew attention to the absurdity of calling foremen to account for events which happened four or five weeks previously; he mentioned the fact that the operating division had set a cost standard for a certain new and important item of product and wished to know whether the cost department could advise him each day as to the variances from the standard cost of this article during the day previous. In view of the fact that the article in question involved the performance of several thousand operations and the cost system in force was designed with the sole purpose of showing the actual cost of finished machines monthly without reference to standards, the chief cost accountant very properly stated that to give this information daily would be a practical impossibility under the existing plan.

Theodore Roosevelt once stated that nine-tenths of wisdom consists of being wise in time, and it can hardly be contended that the demand of the general works manager for information as to where the costs in the day previous had exceeded the standards was an unreasonable one; yet there is probably not one cost system in a thousand under which this requirement could be met. In the cost system which was being discussed, actual cost data were shown without relation to standards, and, therefore, even the monthly costs of the assemblies and machines had little significance considered as a gauge of efficiency. Nevertheless, this cost system is typical of the cost methods advocated in standard works on cost accounting, recommended and designed by professional cost accountants and practiced by large manufacturing concerns.

Obviously, when cost methods do not meet the requirements of progressive works managers something is radically wrong, for in the final analysis the operating man is the one whom the cost accountant will have to satisfy and at the present time there is no question but

*During the past winter Mr. Harrison delivered papers before the New York and Philadelphia Chapters of the National Association of Cost Accountants. There have been numerous requests for copies of these papers. Unfortunately Mr. Harrison was unable to give us permission to publish the papers because they were based upon material which was included in a special article which he had prepared for the first number of "Management Engineering"—the new Journal of Production. Through the courtesy of Mr. Alford, editor of "Management Engineering," we are permitted to reprint this article from advanced proofs of the first number of the magazine which will appear in July. (This note is appended to Mr. Harrison's article in the June bulletin of the National Association of Cost Accountants from which the paper is reproduced.—Ed.)

that the accountant has failed hopelessly to meet the demands made upon him.

In another case with which the writer was familiar very large contracts were taken, the bids submitted being based upon careful cost estimates made by the superintendent. Although the cost system in force was most elaborate and expensive, the superintendent was not able to obtain information as to whether his costs conformed to his estimates until after the completion of the contract when, obviously, the information would be received too late to be of much use. Accordingly, in desperation, he devised and installed a system of his own from which he was able to obtain each day information as to where his costs had exceeded standard and was thus able to control the cost of the work from the start to the finish of the contract. When the writer drew the attention of the chief cost accountant to the valuable results obtained from the superintendent's subsidiary cost plan, the only comment made was to the effect that the superintendent should be disciplined for encroaching on the cost department's territory.

Changing Views of Cost Accountants.

All accountants, however, are not so narrow as the one just referred to, and the writer remembers a short time ago the comptroller of a very large concern expressing himself somewhat as follows:

"We have been operating a cost system which we have been told repeatedly was unusually efficient. We receive hundreds of orders in a month and yet our system will enable us at reasonable expense to determine the profit or loss which we make on every order. After operating this system for many years, however, I have come to the conclusion that it must be regarded as a failure, for it does not give our operating men what they really need and that is information as to inefficiencies. We tell them what it costs to manufacture our product but we do not tell them where their costs are excessive and why they are excessive and I consider that until we do give them this information our cost system cannot be considered as meeting the obligations of my department."

From all this it is evident that the cost accountant is on the verge of making an unpleasant discovery. His position is similar to that of the traveler in whose mind the suspicion that he is on the wrong road has been growing stronger with each mile, in fact has almost developed into a certainty, and who is faced with the bitter fact not only that he has made no headway but also that he will have to retrace much of the distance already traversed.

This is a realization, however, which has to come, and the longer it is postponed the more tragic the awakening. Hence the most hopeful feature of the cost-accounting situation today lies in the completeness of the failure of the cost accountant to meet the needs of the industrial world. Conservatism is the dominant trait of the accountant, and nothing short of total failure would be sufficient to drive him to the wholesale scrapping of traditional ideas and methods which is the necessary first step towards getting cost accounting on a fundamentally correct basis.

Accountant's Failure to Supply Information.

Engaged as he has been in the congenial task of disclosing the mote in the eye of the operating man the cost accountant has failed to perceive the beam in his own, though the engineering profession for the past ten years or so has rather consistently expressed itself in no uncertain terms on the failure of cost accounting to keep pace with industry in general. The main results of these criticisms have been a growing sense of irritation on the part of the accountant as to what he regards as an unwarranted encroachment on his territory, and a widening of the breach between the accountant and the engineer.

There are, of course, cost accountants who will affirm that nothing is the matter with cost accounting and that the methods of cost accounting adopted by the average manufacturing concern under which detailed cost and profit and loss data are compiled monthly are capable of meeting all reasonable requirements. The best proof, however, that these methods do not meet the needs of the operating man is the fact that in large plants it is the rule rather than the exception to find that a subsidiary cost system is operated for the sole purpose of furnishing the works manager with cost information which he cannot obtain from the official cost system.

The lot of the cost accountant of today is by no means a happy one, for in a plant where progressive manufacturing methods are employed he is engaged in one long, hopeless struggle to meet demands for information through the medium of a cost plan which is no more adapted to modern conditions than a system of horse-cars would be to meet the transportation needs of New York City. He endeavors to meet the demands made upon him by introducing little subsidiary plans and contrivances with the indifferent results which usually follow such makeshift methods.

Something is radically wrong with cost accounting and it should be kept in mind that basic defects cannot be corrected by tinkering with surface details. It therefore behooves the accounting profession to relinquish endless theoretical discussions concerning such matters as whether interest should be included in costs or not, and getting down to fundamentals determine what is the underlying reason why the cost methods of today do not meet the requirements of the operating man. He is the one whose requirements must be met by cost accounting.

Present Cost Accounting Unscientific.

Many years ago the writer entered into one of those peculiar English agreements under which, in return for the payment of a substantial premium, he was given the privilege of serving an apprenticeship of five years during which period he received as salary an amount equal to one-half of the premium paid. During the term of his five years' apprenticeship the writer's services were charged to unfortunate clients at rates varying from seven-and-a-half to ten dollars a day and altogether the arrangement was a distinctly advantageous one to the other party to the agreement. In one of the clauses of that agreement it was stated that in return for the investment made and the services given the writer was to be fully instructed in what was grandiloquently termed "the science of accounting." In this phrase lies the whole cost accounting problem, for the basic trouble with cost accounting is that it is masquerading as a science whereas in fact it has no claim to be considered scientific in the slightest degree.

The logical method to determine the correctness or incorrectness of the writer's assertion that the commonly accepted methods of cost accounting are not based on a scientific foundation would seem to be: (1) to establish what the essentials of science are, and (2) to consider whether cost accounting methods generally conform to these requirements.

The word "scientific" is derived from the Latin verb *scire*, "to know," and in the sense in which it is

generally used embraces the conception of all co-ordinated, arranged, and systematized knowledge. The term as employed by scientists, however, is given a more restricted significance, as for instance, in the definition given by John Stuart Mill, as follows:

"Since all phenomena which have been sufficiently " examined are found to take place with regularity, each " having certain fixed conditions, positive and negative, " on the occurrence of which it invariably happens, man- " kind has been enabled to ascertain the conditions of " the occurrence of many phenomena; and the process " of science mainly consists in ascertaining these condi- " tions."

The universe is subject to the operation of immutable physical laws, so that if a certain combination of conditions at one time produces a certain result a recurrence of these conditions at a later time will inevitably duplicate the phenomena previously obtained. It is on this fact that science is based and its practical value founded.

If the wide field of present-day scientific knowledge is surveyed, it will be found that in all its branches the laborious experiments and observations made by scientific investigators have been concentrated in laws and formulas. Formulas represent the fabric of the scientific edifice. The results of a lifetime or many lifetimes are expressed in a single, brief generalization, and each investigator who establishes such a generalization or formula adds a stone for his successors to build upon and carry along the work from the place at which he left off.

As a matter of fact little progress is made in any science until definite principles are laid down and generalizations established. For instance, no definite progress was made in the study of etymology until Jacob Grimm formulated the well-known Grimm's law. Progress was likewise slow in electrical science until Ohm propounded his important law giving an expression for the strength of an electrical current, or the quantity of electricity passing in a given time under certain conditions; nor was much progress made in astronomy until Sir Isaac Newton formulated the law of gravitation. In political economy we find basic generalizations expressed in Gersham's law, as "bad money drives out good"; and even in so subtle a science as that of psycho-physics we have such definite formulas as Fechner's mathematical law that the force of stimulus or excitation increases geometrically while the intensity of sensation increases arithmetically, thus bearing out the philosopher Kant's dictum that any branch of knowledge contains just as much science as mathematics.

The tremendous value of scientific methods is well illustrated in the extraordinary advance which has been made in the field of radio engineering. In 1893, Sir William Crookes suggested that electric waves could be utilized for the transmission of messages through the ether, and between 1894 and 1896 Marconi proved the correctness of the theories to such a point that by 1898 it was possible to send messages between stations 14½ miles apart. Nowadays we have trans-oceanic receiving stations equipped with dictaphone receivers which are so arranged that, immediately one wax record is indented with signals, a second dictaphone record is automatically connected in the circuit, and so on. The use of these records permits traffic to be dispatched across the ocean at the rate of 75 words a minute, the records being then transcribed on a typewriter at speed varying from 30 to 40 words a minute. Surely this is a wonderful advance in less than 22 years.

The Slow Progress of Cost Accounting.

Can it be claimed that cost accounting has made an advance in the last twenty-five years in any way comparable to that accomplished in the field of radio engineering or of other branches of scientific work? In any really important respect are the commonly accepted methods of cost accounting different from those which were laid down by Garcke and Fells in the early eighties? It is true, of course, that improvements have been made in the methods of burden distribution, and particularly in the application of accounting machinery in the routine work of cost compilation; but, considered broadly, these are matters of minor significance.

Assuming that cost accounting is to be considered as coming within the field of science, that costs and cost variations are subject to definite laws which can be investigated and formulated, does it not seem remarkable that in a branch of science so obviously akin to mathematics as cost accounting, its literature has little if anything in the nature of definite laws or formulas?

The troubles of the cost accountant today, therefore, are due to the fact that he has no scientific foundation on which to build; he is an historian, not a scientist. The present trend of manufacturing is towards the future as opposed to the retrospective methods of the past. The complexity of modern manufacturing, the multitude of its parts and operations, make it absolutely necessary that every step in the long chain of manufacturing processes should be predetermined and planned-for in advance. The old-time manufacturer supported by a few capable foremen was able to get along somehow or other, relying upon his experience, the shortcomings of his competitors and a large margin of profit. The modern manufacturer in a highly competitive line, turning out a product involving ten thousand parts and a hundred thousand operations, who attempts to handle such production in the old way is living in a fool's paradise and headed for bankruptcy.

That form of cost accounting which views costs in the retrospective sense solely, which does not consider costs in relation to standards and is not concerned with determining the causes underlying cost variation, is hopelessly at variance with the prospective trend of modern industrial thought. No real progress will be made till the accounting profession awakens to the fact that, like Rip Van Winkle, it has been asleep for twenty years.

ACETYLENE BLOWPIPE FOR REMOVING IRON FRAGMENTS FROM ORE CRUSHERS.

From the Engels Copper Mining Company, Engelmine, California, comes the information that this Company uses the oxy-acetylene cutting blowpipe for removing "hammers" and other "tramp iron" from ore crushers. "We have found this the quickest and easiest, as well as the cheapest way to cut the hammers out of the gyratory crushers" the Company writes.

Practically every mine, large and small, has as a part of its equipment a coarse crusher of some sort. Run-of-mine ore is fed to these crushers, and, even with the utmost precaution, hammer heads and other pieces of metal become mixed with the ore and get into the crushers. Where no preventative devices are used, foreign matter of this kind gets into the crushers quite frequently, and if not removed may damage or seriously interfere with the operation of the equipment.

The experience of the Engels Copper Mining Company suggests a fast, cheap and effective way of handling a difficulty that has been a source of more or less constant trouble in mining plants everywhere.

Segregation in Steel

Some Striking Examples.

By BERNARD COLLITT, F.I.C.*

1. Seamless Boiler Tube, 2½ in. diameter, 2 in. bore.

Although this material was actually purchased for boiler tubes ,it was desired to use some of it for another purpose, and this necessitated expanding a length of about 9 inches at one end of the tube to a diameter of 3 inches and flaring out the end preparatory to flanging. The tools required were made, and the operation of expanding and flaring the tubes was carried out at forging heat in an "Ajax" machine. The great majority of the tubes stood this process quite satisfactorily, but a certain number failed badly, breaking up as shown in Fig. 1. The writer was called upon to investigate the matter and ascertain the reason of failure. One of the defective tubes was selected and a ring cut from it just back of the cracks shown in the photograph. The cut

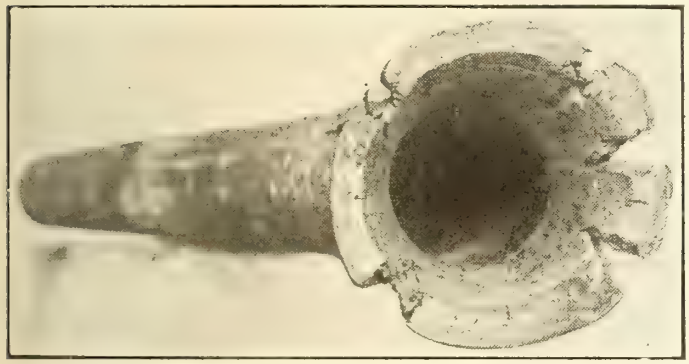


Fig. 1.—Segregated Boiler Tube.

surface of the ring was filed smooth, polished and cleaned, and a sulphur print made: this showed plainly that the tubes consisted of two zones of different composition, an inner one of high sulphur content, and an outer one of comparatively pure steel. The cross section of tube was then re-polished, cleaned, and etched in order to get the best possible contrast between the segregated and unsegregated portions. Fig. 2 shows the appearance after this etching.

Another length of about 9 inchees was cut off the tube, chucked in a lathe, and carefully cleaned up both inside and out by a very light cut: when all scale and rust had been removed, borings from the inner surface and turnings from the outer one were collected separately and analysed. Results are given in Table I, from which it will be seen that the sulphur in the segregated inner layer is six times that in the purer outer layer.

Analyses of Outer and Inner Zones of Seamless Steel Boiler Tube.

Table I.

	Outer Zone %	Inner Zone %
Carbon	.08	.025
Silicon	.020	.025
Sulphur	.026	.155
Manganese	.35	.44
Phosphorus	.024	.049

2. Bright Hexagon Bar, 1.67 inches across flats. (1 inch Whitworth Bolts.)

A piece of this steel, which had broken off in the automatic machine, was brought along for examination. The fracture resembled that of cast iron, but had a bluish tint. When drilling the bar for analysis it was noticed that the drill had entered some internal fissures in the steel, so the remaining portions of the bar were sawn longitudinally and the sawn surfaces roughly polished. Numerous transverse cracks spaced about ⅝ in. apart were disclosed, as illustrated in Fig. 3. Analysis of the material, and the steelmaker's analysis of the cast from which the bars were rolled, are given in Table II, from which figures it is quite evident that the central core of the bar containing .50 per cent carbon, .142 per cent phosphorus and .126 per cent

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* Chief Chemist, Ruston & Hornsby, Ltd., Lincoln, England.

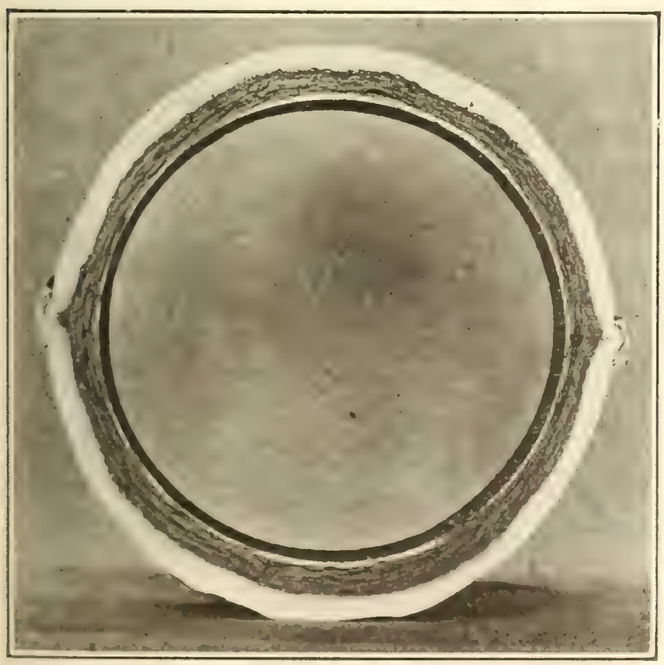
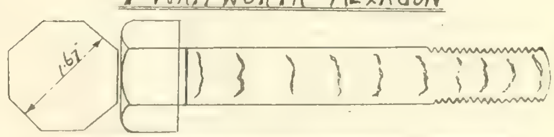


Fig. 2.—Etched Section of Segregated Boiler Tube (natural size)

BRIGHT BAR STEEL.

1" WHITWORTH HEXAGON



	MAKERS ANALYSIS OF CAST	ANALYSIS OF SEGREGATED BAR
CARBON	.19%	.50%
SILICON	.052%	.025%
SULPHUR	.052%	.126%
MANGANESE	.35%	1.10%
PHOSPHORUS	.055%	.142

Table II.

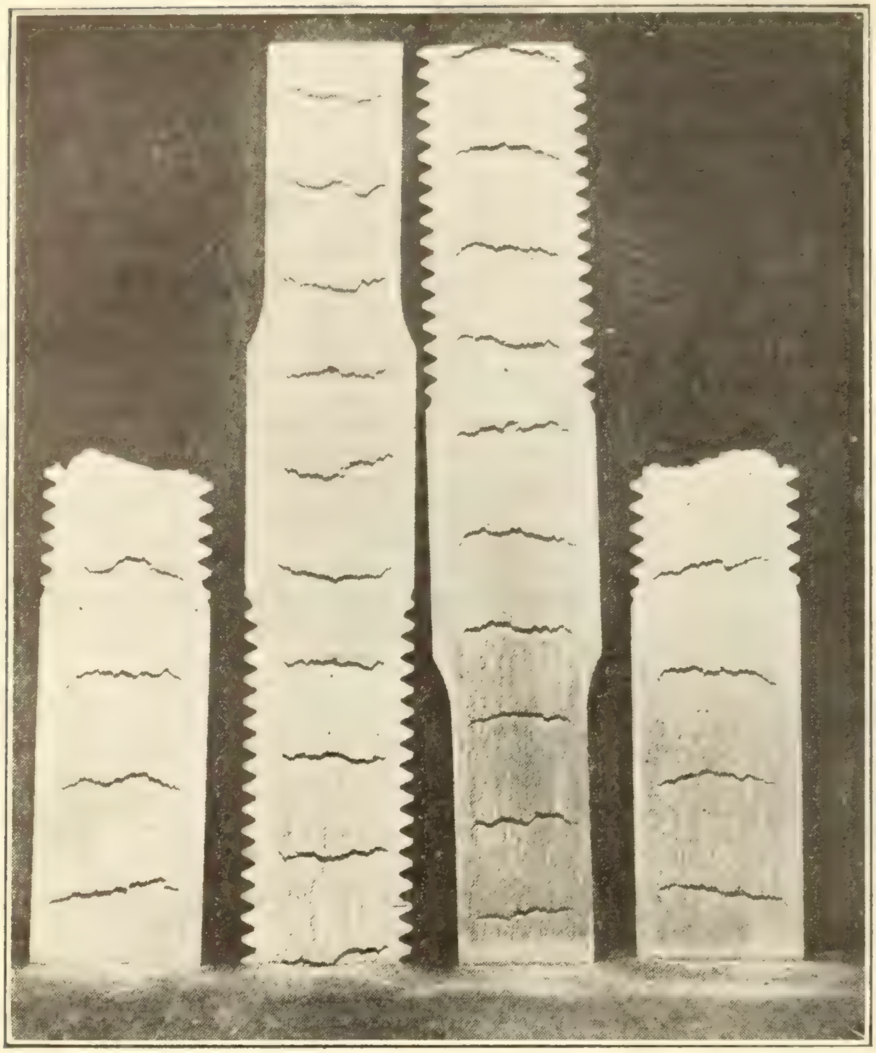


Fig. 3.

Hexagon Bar Steel, showing Internal Transverse Fissures

(7/8 actual size)

sulphur was so much harder and less ductile than the surrounding envelope that it could not elongate to the same extent during the drawing process, but broke up in the interior of the bar.

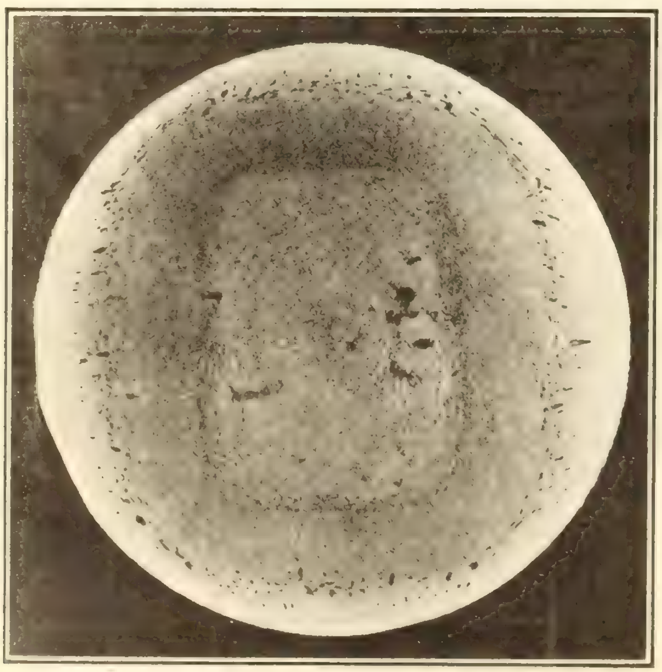


Fig. 4.—3½-inch Bar-Steel (slightly reduced).

3. 3½ in. diameter "20" Carbon Bar Steel.

On a first analysis this gave .107 per cent phosphorus. A cross section of a bar was etched, and showed that a large proportion of the whole cross sectional area consisted of segregated material. Two samples of drillings from the phosphorus-rich interior gave .138 per cent and .139 per cent phosphorus. This specimen is not particularly remarkable except on account of the large percentage of the cross section which was segregated, and on account of the fact that when etched it clearly disclosed the rectangular outline of the ingot or bloom from which the bar had been rolled. This is shown in Fig. 4.

The writer is indebted to his colleague Mr. A. E. Musgrave for assistance in etching and photographing the specimens described in the foregoing.

BELGIAN-AMERICAN COKE OVENS CORPORATION.

A corporation has been organized in New York, headed by Thomas F. Ryan, to introduce and operate in the United States the Piette by-product coke oven. Hector Prud'homme of Brussels is vice-president. Mr. Prud'homme was for several years General Manager of the Acadia Coal Company, at Stellarton, Nova Scotia. The technical part of the organization will be composed of Belgian engineers, and this will be added to by appointment of American engineers and executives.

RESISTANCE TYPE ELECTRIC FURNACE INSTALLED FOR SHEET HEATING.

In the manufacture of automobile body and fender stampings it is of the highest importance that the heating operations be conducted with as little scaling as possible, for any pitting due to this action requires considerable additional labor in getting the defects sandblasted to sufficient extent to get a good finish on the part.

The Mullins Body Corporation, Salem, Ohio, with this in mind recently installed in their new plant a Baily Electric Furnace specially designed for this work. Since a large part of their pressing or drawing to shape is performed cold and only one or two hot runs are required for perhaps six or seven cold operations on the press, it was desirable to build a furnace of the portable type which could be handled by a crane and taken from place to place so that there would be no idle furnaces while the material was receiving its cold runs. This necessitated a furnace with four eye bar connections at the top, one at each corner, for hooking on the crane chains; and also that the transformer and control equipment be located on the top of the furnace as is shown in the photographs.

The furnace is rated at 100 K.W. in electrical capacity, and has a hearth 3'-4'' wide x 6'-5'' long with a door opening 3'-4'' wide x 2'-2'' high. It has a capacity for heating 750 lbs. of material to 1,800 deg. F. per hour. In plants where a crane is not available for moving the furnace, the equipment is designed for mounting on a car which may be moved at will on a truck running parallel to the battery of presses.

One of the notable features of this equipment is the remarkable uniformity of temperature obtained on the sheets, a condition which is not possible to attain in fuel fired equipment where the doors must be opened so frequently, Scaling is also reduced to an almost negligible item, making very much smoother sheets than is possible in fuel fired practice.

Resistance-type Electric Furnace adapted to heating sheets prior to stamping.

It is believed this is the first employment of the electric furnace for heating sheets to prepare them for stamping.

WATER POWER RESOURCES OF CANADA.

(A Memo compiled by the Dominion Water Power Branch.)

During the past two years there has been under way in the Dominion Water Power Branch a careful re-analysis and computation of Canada's water power resources. All existing stream flow and power data, available from Dominion and Provincial sources, have been systematically collated, analysed and co-ordinated with a view to preparing on a uniform basis from coast to coast, revised estimates of the power available. While the analysis is not yet finally completed, sufficient progress has been made to warrant the publication of the figures given herein.

The total available and developed power resources are presented in a manner not heretofore adopted. A consideration of the figures will indicate that they place the water power resources of the Dominion in a much more favourable light than have previously published compilations.

While the resources have been exhaustively analysed in so far as the information available will permit, it should be kept in mind that only very meagre data is to hand in many districts and for many rivers.

Basis of Computation.

The figures listed in the accompanying table and diagram are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration, is definitely known or at least well established. Innumerable rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. This is particularly true in the more unexplored northern districts. Nor is any consideration given to the power concentrations, which are feasible on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record.

In brief, the figures hereunder are based on definite rapids, falls and power sites, and may be said to represent the *minimum water power possibilities* of the Dominion.

The power estimates have been calculated on the basis of 24-hour power at 80 per cent efficiency on the basis of "Ordinary Minimum Flow" and "Estimated Flow for Maximum Development". The "Ordinary Minimum Flow" is based on the averages of the minimum flow for the lowest two consecutive seven day periods in each year, over the period for which records are available. The "Estimated Flow for Maximum Development" is based upon the continuous power indicated by the flow of the stream for six months in the year. The actual method to determine this flow is to arrange the months of each year according to the day of the lowest flow in

each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the maximum for that year. The average of such maximum figures for all years in the period for which data are available is the estimated maximum used in the calculation.

This estimated maximum development is based upon the assumption that it is good commercial practice to develop wheel installation up to an amount, the continuance of which can be assured during six months of the year, on the assumption that the deficiency in power during the remainder of the year can be profitably provided from storage or by the installation of fuel power plants as auxiliaries. The correctness or otherwise of this assumption for any particular site can only be definitely settled by the careful consideration of all circumstances and conditions pertinent to its development. The method, however, enables us to make a fairly satisfactory overall estimate of the maximum hydraulic power available, as distinctive from the estimated ordinary minimum power available.

Available and Developed Totals.

The recorded power available throughout the Dominion, under conditions of ordinary minimum flow and within the limitations set out in the foregoing, is 18,255,000 h.p. The water power available under estimated flow for maximum development, i.e., dependable for at least six months of the year is 32,076,000 h.p. (For details see table attached).

There are installed throughout the Dominion water wheels and turbines to the extent of 2,471,000 h.p. However, it would not be correct to place this figure in direct comparison with the minimum or maximum available power figures quoted above and therefrom deduce the percentage of the available water power resources developed to date. An allowance must be made for the average ratio between the water wheels installed and the power available.

An analysis of the water power plants scattered from coast to coast, concerning which complete information is available as to turbine installation and satisfactory information as to stream flow, gives an average machine installation 30 per cent greater than the six month flow maximum power. Applying this, the figures quoted above therefore indicate that the *at present recorded water power resources* of the Dominion will permit of a turbine installation of 41,700,000 h.p. In other words the present turbine installation represents only 5.9 *per cent* of the present recorded water power resources.

Process during past year.

In spite of the outstanding facts that financial and commercial conditions are still far from normal and that costs of construction are almost prohibitive for all but absolutely necessary undertakings, there has been during the past year and is now, marked activity in hydro power construction. This has resulted from a variety of causes principal among which is the lack of native coal in the central industrial district and the fortunate location of economic water power sites to industrial centres.

The total hydro power development installed during the past year or now under construction represents approximately 560,000 h.p. of installed capacity. This figure includes only the initial installations of plants under construction, not their ultimate designed capacity. It is evidence of the manner in which the water power resources of the Dominion are being put to effective and productive use.

Future Growth in Utilization of Water Power.

It is profitable to consider the history power utilization in Canada during the past few years in conjunction with the present cativity with a view to making some reasonable forecast as to its probable future growth. Should the rate of water wheel installation during the past fifteen years be maintained, there will be installed in 1925, 3,360,000 h.p.; in 1930, 4,110,000; in 1935, 4,860,000 h.p. and in 1940, 5,600,000 horse power. In view of the increasing appreciation of the advantages of hydro power combined with the fortunate location of ample supplies within easy transmission distance of practically every great industrial centre throughout the Dominion, there is every reason to anticipate that the rate of growth in utilization will be accelerated rather than retarded. Reference to the foregoing totals of water power available will indicate that this anticipated increase in utilization will not seriously reduce the total reserves. Canada possesses sufficient reserves of water power to meet all anticipated demands for many years to come.

In order to ensure the most beneficial utilization of these reserves and to provide intelligent guidance for their development, two essentials are required:—

1st.—An accurate knowledge of the location, capacity and the engineering and economic possibilities of development of the water powers throughout the Dominion, together with their relationship to other natural resources of mine and forest, to industrial centres and opportunities, to transportation systems — rail and navigation, to coal and fuel supplies, to irrigation, drainage and reclamation projects, to alternative sources of power and to market for and uses of power in general.

2nd.—A sound governmental administrative policy designed to protect the public from inadvisable and ill-designed power schemes and to provide for reasonable regulation and revision of rates and rentals, and at the same time to ensure satisfactory guarantees for the encouragement of legitimate investment in hydro power enterprises.

True conservation of our water power resources, which are inexhaustible through use, lies, not in withholding them from development, but in their efficient utilization in the public interest for the economic exploitation of our other natural resources, and for the conservation of our exhaustible fuel supplies.

The water power now developed in Canada represents an investment of $475,000,000. In 1940 should the rate of growth in installation during the past 15 years be continued, this investment will have grown to over $1,000,000,000. The present development represents an annual equivalent of 18,500,000 tons of coal which, valued at $8 per ton, represents $148,000,000. In the year 1940 these annual figures will, with the foregoing assumption, have become 42,000,000 tons and $336,000,000. These figures are striking evidence of the outstanding importance and necessity of an intelligent administrative policy governing the development of our water power resources.

Available and Developed Water Power in Canada.

Province 1	Available 24-hr. power at 80 p.c. efficiency. At ordinary min. flow h. p. 2	At est. flow for max. dev. (Dependable for 6 mos h.p. 3	Turbine Installation h. p. 4
British Columbia	1,931,142	5,103,460	304,535
Alberta	475,281	1,137,505	32,492
Saskatchewan	513,481	1,087,756	
Manitoba	3,270,491	5,769,444	83,447
Ontario	4,950,300	6,808,190	1,052,048
Quebec	6,915,244	11,640,052	925,972
New Brunswick	50,406	120,807	21,180
Nova Scotia	20,751	128,264	35,774
Prince Edw. Island	3,000	5,270	1,933
Yukon & N. W. Terr.	125,220	275,250	13,199
	18,255,316	32,075,998	2,470,580

The figures listed in Columns 2 and 3 in the above table represent 24-hr. power and are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration, is definitely known or at least well established. Innumerable rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded, and which will only become available for tabulation as more detailed survey work isi undertaken and completed. This is particularly true in the more unexplored northern districts. Nor is any consideration given to the power concentrations which are feasible on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record.

The figures in Column 4 represent the actual water wheels installed throughout the Dominion. These figures should not be placed in direct comparison with the available power figures in Columns 2 and 3 for the purpose of deducing therefrom the percentage of the available water power resources developed to date. The actual water wheel installation throughout the Dominion averages 30 per cent greater than corresponding maximum available power figures calculated as in Column 3. The figures quoted above therefore indicate that the *at present recorded water power resources* of the Dominion will permit of a turbine installation of 41,700,000 *horse power*. In other words, the present turbine installation represents only 5.9 *per cent* of the present recorded water power resources.

The above figures may be said to represent the *minimum water power possibilities* of the Dominion.

As illustrative of this, the detailed analyses which have been made of the water power resources of the provinces of New Brunswick and Nova Scotia have disclosed most advantageous reservoir facilities for regulating stream flow and it is estimated that the two provinces possess within their respective borders 200,000 and 300,000 commercial horse power. These figures provides for a diversity factor between installed power and consumers' demands.

ENGINEERING CONFERENCE, LONDON, 1921.

By Colonel DAVID CARNEGIE, M. Inst., C.Q., F.R.S.F.

The Annual Engineering Conference was held during the three days ending July 1st at the Institution of Civil Engineers, London.

In the Mining and Metallurgical Section some interesting papers were read and discussed. I should like to refer to three of these, the first upon "The Elastic Limit" by Professor Dalby, the second on "The Existing Practice of Inspecting Work and Materials" by Mr. George Hatton, and the third on the "Damage to Tires and Rails caused by Brakes or Slipping Wheels" by Mr. C. F. Sandberg.

1.—The Elastic Limit.

Professor Dalby in his opening remarks says the difficulty of defining the elastic limit is due to the fact that the term is used in more than one sense by Engineers. Without traversing the various uses of the term, it will be generally agreed that the term 'elasticity' in its broad sense, means the power of a material to recover its primitive form after loading has been applied and removed.

Recovery may be partial or complete. The power of complete recovery is lost when the stress produced by loading has once passed beyond a certain limiting value peculiar to the material.

Below this limiting stress the extension of a steel test-piece is proportional to the load producing the extension.

Above this limiting stress the extension increases at a greater rate than the load.

This limit, therefore, is called the limit of proportionality, and the term elastic limit is often used to define this point.

Professor Dalby used an automatic recorder of his own design for tracing the stress strain diagrams in the experiment. The instrument was attached to the testing machine and engaged with two collars turned upon the test pieces at distances apart where usually lines or centre-marks are made from which to measure any extensions. The slightest extension of the test pieces is photographed by means of a spot of light starting from zero on the scale. The spot moves along a straight line to the point marking the limit of proportionality. The line bends away and then the material yields.

If Professor Dalby could simplify this automatic recorder so as to apply it to Works practice, it would be a most valuable adjunct to the testing laboratory.

These experiments revealed one or two interesting things.

The behaviour of irons and steels differs after overstrain.

It is known, he states, that iron and soft steels tend to recover their property of proportional elasticity by mere lapse of time, and the state is reproduced in very short time by moderate heating, as, for example, by mere boiling in water.

But the hard steels and the alloy steels do not share this property. After overstrain they remain in that state without recovery indefinitely, and recovery can only be brought about by heating to high temperatures.

In his concluding remarks he states that the exact definition of the term "elastic limit" is a matter of some difficulty because of the current use of the term in several senses. The term limit of proportionality may be used for the exact definition of one point in the load extension diagram, without interfering with the present uses of the term elastic limit.

The limit of proportionality of a material is not a fixed point, but varies with heat treatment and vanishes with overstrain.

2.—The existing Practice of Inspecting Work and Materials.

Mr. Hatton's paper contains a suggestion for a Central Inspection Bureau, having possibly headquarters in London and branches or offices in the various manufacturing areas throughout the country, to which professional engineers could send their specifications and instructions, and from which inspectors could be sent daily short distances only to inspect work and material, the Bureau to report thereon to their clients.

The scheme was supported by several speakers who told of the waste of time, energy and money together with inefficiency, which marked much of the present method of inspection. It was pointed out that sometimes as many as 25 Inspectors might be at a large Steel Works at one time, delays in production without adding to the quality of the output resulting.

The Inspection Department of Lloyd's Register of Shipping was instanced as an admirable example of what might be accomplished in a larger and more general way in the form of a Central Inspection Bureau. The increased standardization of specifications for materials and methods of inspection as well as the suitable training of Inspectors were strongly recommended.

3.—The Damage to Tires and Rails Caused by Brakes Slipping Wheels.

Mr. C. P. Sandberg referred to the nature of the damage usually caused to tramway and railway rails.

It consists of a series of surface cracks or tears upon both the brake block and the wheel or rail, the cracks running in a direction at right angles to the motion and forming at regularly spaced intervals evidently bearing a relation to the periods of seize and slip. The places of damage upon the rails are usually where rolling stock is frequently and suddenly stopped, such as at railway depots and tramway termini.

The cause is explained by the limited rate of heat conduction of the materials used under the intense pressures which are now frequently employed for the rapid deceleration of vehicles. Several remedies were suggested.

1. Harder rails in suitable lengths placed where regular and frequent stoppages of vehicles takes place.

Manganese Steel and Alloy Steel rails were suggested.

2. As less damage was done to tramway tracks than to railways due to the above causes, it was suggested that rails used for railways should have more support where braking was applied by putting the sleepers closer together at such places.

3. The renewal of ordinary rails at such parts more frequently.

4. The more frequent inspection of rails at such parts and the application of a means for testing the magnetic permeability of the defective lengths, as the depth of a crack on the surface of a rail cannot be estimated by ordinary superficial inspection.

5. The use of metals for brake shoes with a higher thermal conductivity, such as alloys of aluminium. With regard to the damage to tramway wheel tires, it was considered that from the point of view of public safety, it was most desirable that more frequent inspections of the parts of rails likely to be affected by such braking action should be observed and that replacement of ordinary rails should be made.

BITUMINOUS COAL PRODUCTION IN THE UNITED STATES.

The weekly bulletin of the United States Geological Survey on coal production in the United States contains the following comparison of the production of bituminous coal during the first half of 1921 against corresponding production in nine years preceding.

Year	June production	Cumulative production to June 30
1913	37,405,000	226,000,000
1914	31,412,000	205,000,000
1915	33,957,000	193,000,000
1916	37,742,000	246,000,000
1917	46,834,000	273,000,000
1918	51,138,000	282,000,000
1919	37,034,000	214,000,000
1920	45,114,000	258,000,000
1921	33,852,000	196,000,000

If the second half of the year 1921 shows no greater output than the first half, the total for the year will be less than 400,000,000 tons. The last year in which the country required less than 400,000.000 tons was 1909.

Examination of the table shows that up to the end of June, the year 1921 was:

9 million tons behind 1914
18 million tons behind 1919
30 million tons behind 1913
50 million tons behind 1916
62 million tons behind 1920
77 million tons behind 1917
86 million tons behind 1918
3 million tons ahead of 1915

Compared with the average of the eight years preceding, 1921 is 41 million tons behind. Before concluding that this subnormal production indicates a future shortage, the greatly decreased consumption of coal caused by the depressed condition of industry in general should be considered. Cumulative production is but little less than that in 1914, which also was a year of general business depression. In that year no shortage of soft coal occurred. It is even slightly ahead of the first half of 1915 when the allied war orders had not begun to stimulate the demand for coal. On the other hand our national requirements normally increase at the rate of from 10 to 20 million tons a year, so that what was sufficient in 1914 would ordinarily be far from sufficient now.

MASSEY-HARRIS FACTORY CLOSES DOWN.

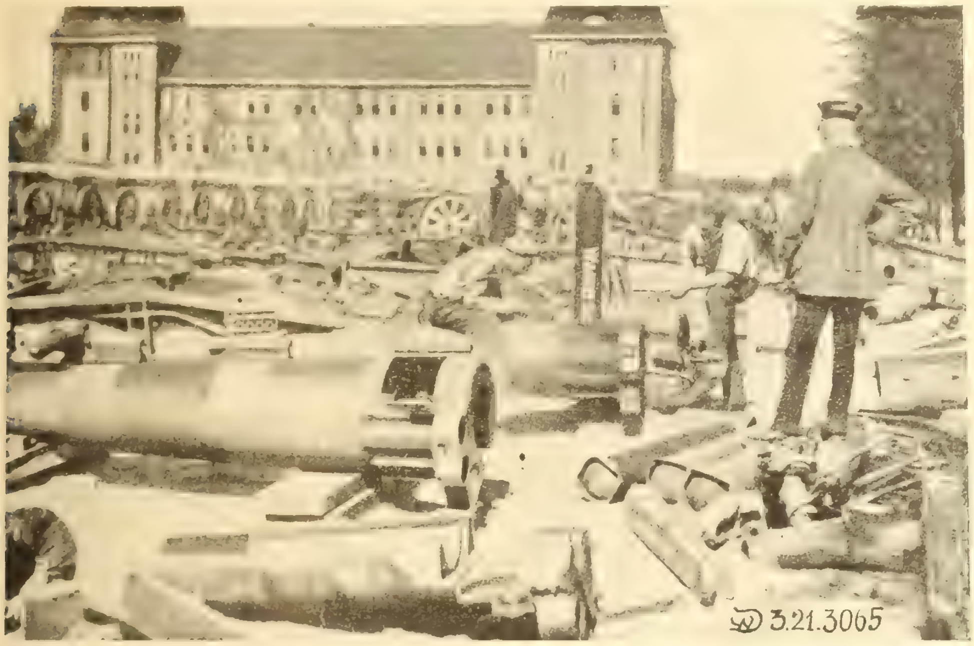
By Our Toronto Correspondent.

The Massey-Harris factory in Toronto has closed down. With unemployment so widespread, and increasing in volume in the city, this is naturally a very serious factor in a serious situation. For this huge agricultural implement concern, which constitutes the largest single industry under one management in the British Empire, normally employs some thousands of workers. Lack of buying, on the part of the agricultural community, is the cause of the shut-down. In a statement issued by the general manager of the Company on the 2nd August, it is said that "owing to disappointing sales during the last season, with warehouses—at headquarters at home and abroad—heavily stocked with implements," the works have to be closed.

Nor is any indication afforded as to the date when they are likely to reopen "So much depends," the statement continues, "on the outcome of the present

harvest that we really cannot venture a guess as to when we can open again The works will reopen as soon as conditions justify." Notifications is made that there will have to be a downward adjustment of wages, "as it will be impossible, next season, to sell goods without a substantial reduction in the cost and price," and, as to the amount of the inevitable wage reduction, the management will be guided by conditions as they prevail at the time of reopening.

Coming almost simultaneously with the taking of steps by the Provincial Hydro-Electric Commission, which involve the laying off of some thousands of men at Chippawa—the majority of whom will probably swell the ranks of the unemployed in Toronto, where, indeed, many of them have their homes—this shut down cannot fail gravely to accentuate the really serious aspects of the unemployment situation in this city.



Germans breaking down guns and mountings under terms of the Versailles Treaty, using Oxy-Acetylene Blow-Pipe. From the advertising bulletin of a Westphalian factory.

POSSIBLE APPLICATION OF THE "MYSTERY GUN" TO MINING.

A correspondent of the "Manchester Guardian" couples the name of Sir Edgar Jones, M.P., with the noiseless gun, said to have been invented by an Englishman who was a member of the British Inventions Board during the war. In reply to the questioning of the correspondent, Sir Edgar stated:

"I have seen it and took a lot of interest in it when I was in New York. But I am not interested in it as a gun, but in its application to industry, particularly to coal-mining and quarrying. It is a very small instrument, that will make blasting with powder unnecessary. These developments are proceeding, and one of these days I think we shall have a very considerable and remarkable development.

"It is true that as a gun it will revolutionize gunnery, because it has no recoil and makes no noise. The inventor is not keen at all in applying his discoveries to destruction but in making them applicable to production. And it is from that point of view I am interested.

"Who is the inventor? He lives just outside London, and is working away to apply the invention to industrial purposes. But as a gun, I think our own people were getting ready to use it before the war ended. The inventor is a very clever man. He was a member of the Inventions Board, and has several important inventions all over the world. The arrangements for the trials of which the cables speak now were made when I was in New York.

"What of its applicability to mining?"

"Well, here is the instrument" (measuring a space

of about a foot.' The man with it goes up against the face of coal. He works the instrument, and 'biff,' splits the whole face of the coal. Then all he has to do is to get the coal out. It is not a blasting operation. It is just the delivery of a blow at a terrific velocity on a small patch which cracks the whole piece. It will crack granite or slate or any hard rock. It is very small but very complicated and very effective. There is no contact with the air, and therefore no sound and no recoil. It is based on new mechanical principles absolutely."

BRITISH COLUMBIA MINES REPORT.

The Annual Report of the Provincial Mineralogist for British Columbia to the Minister of Mines for 1920 is to hand, and is once more notable for the bulk and excellence of its contents, for beauty of its photographic reproductions we have seen. No province of Canada contains such a varied wealth of minerals as British Columbia, or has its mines situated in such scenic positions, as may be readily observed from perusal of the report, with its plentiful photographs and maps.

The following table, extracted from the Report, with the percentages calculated, shows the relative importance of British Columbia minerals, as mined to date, and the standing of 1920, which has only been exceeded in value of mineral production by the years 1916, 1917 and 1918.

Mineral Production of British Columbia.

	Total for all years up to and including 1920. $	Per cent.	Production in 1920. $	Per cent.
Gold placer	75,944,203	10.8	221,600	0.6
Gold, lode	102,753,823	14.5	2,481,392	7.0
Silver	53,668,284	7.6	3,235,980	9.0
Copper	161,513,864	22.9	7,832,899	22.0
Lead	46.637,221	6.6	2,816,115	8.0
Zinc	19,896,466	3.0	3,077,979	8.6
Coal and Coke	212,573,492	30.0	13,450,169	38.0
Miscellaneous	33,205.625	4.6	2,426,950	6.8
	$706,192,978	100.0	$35,543,084	100.0

EXPLOSIVES MANUFACTURE IN CANADA.

The report of the Dominion Bureau of Statistics on the explosive industry in Canada for the year 1918 is interesting as a record of a phase of munitions activity, and the figures of that last year of the war, while impressive as showing what the country can do under the compulsion of war necessity, are not representative of normal business in the explosives industry in Canada.

The value of explosives made in Canadian factories in 1918 is placed at $1,477,828, and the value of exports of cartridges, explosives and detonators from Canada in that year is placed at $272,913,776. There is therefore a very wide spread between the two sets of figures, representing, presumably, costs of making explosives into shells of various types, and taking in probably the product of the previous year's output.

The report states that over five million dollars was spent in Canada during 1918 in the construction of new buildings and the repair of those already constructed. The investment in plant and equipment in the explosive industry in 1918 was nineteen million dollars. No doubt, by this time, much contraction in the scope of the explosive industry has taken place, but it is evident that there should be no difficulty in supplying Canadian industries with explosives in ample quantity in ordinary times.

The Bureau of Statistics is co-operating with the Explosives Division of the Mines Branch in the obtaining of statistical data, and a joint form for collection of such information is being used. Of interest to the coal-mining industry in Canada is the use of over five million pounds of toluol in 1918.

WHAT A GREAT IRON AND STEEL INDUSTRY MEANS.

Under this heading the South African Mining and Engineering Journal reproduces from "Iron and Steel of Canada" a comprehensive photograph of the Sydney Plant of the Dominion Iron and Steel Company, commenting thereon that "Coke ovens, blast furnaces; and, in the distances, shipping piers, testify to the growth of a great industry and its many ramifications."

ST. JOHN, N.B. BRASS FOUNDRY CLOSES.

Thos. McAvity & Sons have suspended work in their brass foundry, stocks of brass goods on hand being sufficient for one and a half to two years requirements. Reductions in staff have been made in recent months, and a little over a hundred men will be displaced by the suspension.

EDITORIAL

A Retrospect

WITH this issue a change will take place in the editorial direction of "Iron & Steel of Canada", and the Editor bespeaks for his successor the same kindly consideration and help from the leaders of the steel and iron industries in Canada as has been given to himself.

In comparison with the unparalleled sister industry in the United States, the importance of our own industry is dwarfed, if considerations of tonnage and market alone are taken into account. By themselves they are a little too overshadowing to permit entire equanimity on this side of the line. The *clientèle* of a Canadian periodical devoted to the iron and steel trades of the Dominion is, by comparison with the long-established and wealthy trade journals of the United States, a limited one, seeing that the maximum recorded annual output of steel in Canada is a little short of 1¾ million tons, whereas that of the United States has reached 45 million tons. Nevertheless, we believe that the statement made in a foreword in our issue of June 1919 is not less true today, namely, that "the extent of the steel industry in any country is a fair index to that country's progress in the arts", and that, small as Canada's steel production may be, it is, relative to our population, a most important and very necessary part of our national economy. Similarly, a trade journal devoted to presentation of the Canadian interest and viewpoint concerning the iron and steel trades, is a necessary enterprise, and "Iron & Steel of Canada" has striven since its inception to "represent Canada's premier industry from a national standpoint."

In taking a general survey of the industry two years ago we ventured the opinion that "while the steel in-" dustry in Canada is to outward appearance a sturdy " growth, its future cannot but cause anxiety amongst " those whose livelihood and investments are dependent " upon it, so long as practically all the iron-ore used in " Canadian blast furnaces, a large part of the fuel used " in smelting the ores, and virtually all the manu-" factured refractory materials used for linings in " furnace processes and in coke ovens are imported " from non-Canadian sources."

Close observation of the progress of the domestic steel industry during the intervening period indicates a keen appreciation on the part of those who direct it of the need for greater independence of outside sources. Much progress has been made, in face of great difficulties, because, as we have previously affirmed, the national needs of Canada are all too often opposed to our financial advantage.

The state of trade is not such at this time as to permit any attempt at forecasting what the future requirements of Canada in steel are likely to be. This question is one that is puzzling not only this Dominion but the whole world. While the beautiful concept of world peace and disarmament is far from being realised, it seems not unlikely to expect that the next few decades will see a smaller consumption of metals in munitions manufacture and in building of warships and cannon than has previously been the case in this generation. In the past two years the salvage of metals from munitions and the disarmament of the central powers has greatly obscured demand in the metal markets, and, while it is recognised that steel production in the past year has descended to unprecedentedly low levels, and while it is also known that all kinds of construction work has been deferred until the apparent outlay required was smaller (or until the medium of exchange had become stable), yet no really trustworthy opinion can be formed as to what will be the requirements of the world in the way of iron and steel in the years immediately ahead of us.

Canada Well Provided With Steel Plants.

JUDGING, however, from the pre-war figures, and the doubling of steel production during the war period, it would seem as if the capacity of the existing steel plants in Canada were sufficient to meet the country's requirements for some years to come, in view of the slow increase in the growth of our population and the likelihood of money stringency during the long period of recuperation from war and payment of war debts that lies ahead.

The country now possesses a sufficient number of blast furnaces, although it is to be doubted whether the steel refining capacity is as large or as modern in its character as is desirable. In regard to steel-rail rolling capacity, forging plants, structural steel and small-section rolling mills; wire and rod mills, and plate and sheet mills, the country is fairly well supplied. At least two of the large steel companies are now in a position to make firebrick and silica brick for their own use in connection with coke-oven and metallurgical processes, and for general outside sale. The by-product coking plants of the larger steel companies are both adequate and modern, and by-product and benzol-recovery

plants are installed. The manufacture of slag fertilizer, and utilisation of the slag dumps for paving material is now usual practice. Speaking generally, the plants of the steel companies are in good physical shape, and, financially, the position of the steel companies is much better than market quotations on their stock issues would indicate.

Summing up the position of the primary producers it would appear that they have fair financial reserves, plants in good order, fitted to make all the steel and steel products the country is likely to ask for in the immediate future, and not requiring heavy capital expenditures either for increase of plant or modernisation thereof, so far as the steel works are concerned. Some modification of this statement is necessary in regard to those companies possessing collieries and iron-ore mines.

Iron Ore Mining Deferred.

SO far as iron-ore mining in Canada is concerned, it does not at this time exist, and financial prospects are such as to indicate that for some years the iron-ore used in Canadian blast furnaces will continue to be imported. The revival of iron-ore mining in Canada, and its future great importance is a very certain development of the future, but the time is not yet.

The Secondary Industries.

THE secondary industries are differently situated. Their growth has been at a much greater rate than the growth of the blast-furnace enterprises, and bids fair to proceed at a small greater rate. The aggregate of foundries, machine-shops, automobile plants, agricultural implement works, railway rolling-stock and equipment manufacturers, machinery manufacturies, electrical companies, water-machinery plants, and the thousand and one branches of the metal trades include a far more imposing extent of investment and employ many more workmen than the steel-plants proper. There seems no reason to anticipate any setback to the steady growth of these industries, and it is to them that the blast-furnace and open-hearth plants of Canada must chiefly look for an outlet for pig-iron, steel ingots, and partly finished steel products. The growth of the secondary industries has been most remarkable in the West, a feature of Canadian development that is very likely to continue and to increase in significance.

Export Business.

THE extent to which Canada can become an exporter of iron and steel goods during times of peace is problematical, and will depend chiefly on the cost of producing coal in Europe as compared with Canadian costs. If the cost of coal can be sufficiently lowered, the Nova Scotia companies ought to be able to realise one of the aims of the original promoters, namely the export of pig iron to Europe. The ability to do this, however, is altogether a question of the cost of coal production.

Steel Manufacture in the West

THE possibility of an iron and steel industry on the Pacific Coast, while it is much talked of, is, under prevailing conditions of trade, and those which appear to be in prospect, something that will be indefinitely deferred. When, and if, such an industry comes about, it will be as a result of the pressure of western coal producers for a market for coal, and of the increased requirements of the western population for iron and steel goods which the growth of coal-mining there will cause. The presence of coal creates markets and draws population, and, wherever coal exists, if it is at all possible to bring iron-ore to the coalfield, there iron and steel industries will develop. The West will have its iron and steel plants, but not yet awhile.

Favourable Location of Central Plants.

THE steel plants of the central provinces of Canada are quite frankly an extension of the industrial stimulus of the great central coalfield of the United States. Their existence is the outcome of a desire on the part of the Canadian people to benefit from the large employment and monetary advantage, and the increased national independence, which the large use of iron and steel in Canada suggested might be obtained by the erection of steel plants inside our own boundaries. These industries are admittedly protected by tariffs and probably could not exist if tariff protection were withdrawn. Nevertheless, on the grounds of geographical location, nearness to fields of coking coal and large deposits of kindly iron-ores, and access to great waterways, these plants have many advantages, and are not open to any accusation of being the creation of fiscal artificialities. Were there no international boundary, and no desire on the part of the Canadian people to own a distinctively Canadian industry, there would be plants at or near the locations indicated. It is because of this that the tariff protection of Canadian steel manufacture has never been heavy, or of such extent as to react onerously against users of iron and steel in the Dominion. In fact, the tariff protection has been so nicely balanced that it has put the Canadian steel companies on an everlasting defensive, and has not permitted them to indulge in any financial easiness or reckless expenditure.

Generally speaking, the iron and steel industry in Canada is the outcome, first, of a real demand for steel materials; second, the possession of suitable sites for steel manufacture; third, the partial possession of the raw materials required, or close proximity to their occurrence in the United States and Newfoundland; and lastly a statesmanlike policy on the part of successive Canadian administrations to bring about, by bonuses, tariffs and home consumption, realisation of the widespread desire of the Canadian people to possess a domestic steel industry.

Steel Industry Will Grow with Canada.

As our national consciousness increases with the inevitable growth of our population and national importance, it is not to be expected that the country will desire to see the steel industry become relatively less important, or will permit it to become so. There are a good many branches of iron and steel metallurgy and metal-working that have not yet been commenced in Canada, and we may expect these to be added as the years go by. The present eclipse of shipbuilding is the result of a somewhat premature commencement, under stress of war necessity, but the day is coming when the shipbuilding industry in this country will become as much a staple industry as it is in Britain. Why should it not? We have all the advantages that Britain has, and many more added thereto.

While therefore not seeking to disguise the fact that there are a number of conditions attaching to the iron and steel industries that cause uneasiness, and prevent a dangerous complacency, the outlook on the whole is a cheerful one. The industry exists because it fills a national demand, and as the nation grows that demand will become more insistent. Iron and steel production in Canada is only a new thing, barely twenty years of age, and on the present scale it is less than ten years old. It has lived through some youthful indiscretions, and, after rendering a really marvellous assistance in the output of munitions during the war period, it is today a tested part of our national economy, a noteworthy provider of employment and one of the substantial buttresses of Canadian trade and commerce.

The fundamentals of the iron and steel industry in Canada, while they do not justify the boundless enthusiasm that has been at times expended upon them, are fully as sound as those of any other industry in Canada, and they permit of much sane optimism.

THE COST OF LIVING.

The tabulation which appears each month in the "Labour Gazette" on the cost of foodstuffs averaged over sixty cities and towns in Canada commenced publication in 1915. The tabulation was the result of the recommendation of a parliamentary committee early in 1914, and it is fortunate that the work of recording and tabulation was undertaken before the War. The tabulation covers the cost of specified items of necessary living expenditures calculated for a family of five with an income (before the War) of eight hundred dollars per annum. From time to time criticisms of this tabulation have been heard. The selection of the items it covers, and the accuracy of the prices upon which the averages are reckoned, has been questioned, but careful checking of the figures and averages will convince any impartial observer that the work has been well and correctly carried out. It must also be allowed that the same selection of items, tabulated over a long period of years, will give a correct account of the rise and fall of living costs, despite any difference of opinion which may arise as to the fitness of the items selected.

The work of the Department of Labour has now continued long enough to make it possible to review the monthly variation in the cost of foodstuffs, fuel and light and rent over a period covering almost eight ysars, and the information available is most ample in regard to foodstuffs. The cost of the weekly budget of foodstuffs in 1914 varied between $7.50 and $8.00, and there was no notable increase in prices until the last quarter of 1916, when the curve began to mount rapidly. At the time of the Armistice the weekly budget had risen to $13.50, and the curve showed a tendency to steady, and even to reverse itself during the six following months. In the last half of 1919 the upward course of prices was accelerated and the curve became very steep, reaching a peak at $17.00 in June 1920. Since July 1920 prices have declined with greater rapidity than they rose, and the latest report for July 1921 gives the necessary expenditure on foodstuffs as $11.00 per week, bringing prices back to approximately where they were in the Spring of 1917. The cost of foodstuffs has therefore dropped in twelve months by a figure that is equal to the rise of the thirty-eight months previous to June 1921.

A continuation of the rate of decline in the cost of foodstuffs manifested since June 1920 would result in the weekly expenditure falling to 1914 figures by the end of the current year. The decline has been so marked and so precipitate that some flattening of the descending curve is not improbable, but there is every reason to believe that the tendency will be downwards for months to come, except as it may be locally influenced by actual failure of crops and transportation difficulties.

The more important wage advances given in the United States dated after the Spring of 1917 and the most far-reaching of the wage advances, that given to the railwaymen under stress of war conditions in the United States, was, somewhat incongruously, extended automatically to Canada; and, combined with the increases given to coal-miners, brought about the most considerable portion of the increased cost of living. It should not therefore pass unnoticed at this time that foodstuffs, representing approximately sixty percent of living costs, have returned to where they were before the United States went to war, and before wage increases had become general.

EN PASSANT.

In a thoughtful address delivered by Mr. Edgar Crammond to the Institute of Bankers in London on June 28th last the speaker defined Capital as meaning "in its ultimate analysis principally organisation." In such matters of negotiation between Capital and Labour as wages and hours—matters in which differences of opinion can hardly be avoided — Mr. Crammond suggests that it would be a piece of incomprehensible folly on the part of Labour, at a period when the world is entering upon an era of intensive competition, to weaken the position of the organisers in the great competitive mar-

kets of the world. In regard to Capital, Mr. Crammond suggests that it is of no avail to point out to workers that the war caused tremendous losses which will involve a lower standard of living, but that a constructive policy must actuate any proposals put before workmen.

It will be generally recognised by those who have had to do with employment during the last few years that the questions of rate of remuneration and length of working day are secondary in their damaging effects on business to the general destruction of organization in industrial enterprises. Labour leaders, who need votes to keep in power like democratic politicians, have pandered to the mediocre and least efficient in union ranks, and they have brought about thereby a condition that prohibits the efficient man from demonstrating his real capacity, and strangles productivity to prevent exposure of the inefficient. Even if one admits the full implications of the slogan of the international trade-unionist, namely, "All wealth belongs to the producer," it should be fairly evident that there can be no greater amount of wealth for distribution than is produced by labour. If production is hindered, the creation of wealth is correspondingly hindered. Negotiations between employers and workers in recent years have been marked by a consistent demand on the part of the workers for less work and work of an easier kind. The demand for higher wages, and the granting of this demand, has been more a reflex of inflated paper currencies than anything else, and when remuneration for labour is received in tokens that change in purchasing value, it is really very difficult to gauge the effect of wages upon production. The definition of a "fair day's pay" is difficult, but, in some quarters, the definition of a "fair day's work" is clearly declared to be as little work as possible. This is the view of those who regard the capitalist as the chiefest manifestation of original sin, but there is a large and influential body of workers who cannot see where employment is to come from if the employing agency is destroyed. It might be well borne in mind by both sides to this eternal controversy, in the days immediately ahead of us, that a fair day's work is the only condition which will enable the employer to give a fair day's pay. The pay admittedly is created by the work, and if the work is not done, then the pay will not be forthcoming.

MR. CRAMMOND further comments on the fact that in 1921 the percentage of national income in British which is expended on national services is 23 per cent, comparing with 8½ percent in 1914, and that the amount of money left for replacing depreciation of works and the maintenance of capital investment, for new investments at home and abroad, has dropped from 23.7 percent in 1914 to 5.4 percent in 1921. The mere cost of government and national defence in Britain is now estimated to take 32 percent of the national income. Similar conditions face Canada, the United States, France, Italy, Spain and Japan. A more convincing argument for general world disarmament could scarcely be adduced. Under such conditions it is a disturbing thing to observe that the nations of the world are now feverishly building the biggest warships, the biggest guns, the largest radio-stations; are perfecting the deadliest toxic gases, designing new weapons of precision for bombing from airplanes, developing fast and mobile "tanks", and doing many other things the world is not told about, all in preparation for future wars. The bright spot on the horizon is President Harding's invitation to a disarmament conference. If the Kaiser has a sense of humour — which is improbable — he might sweeten his remorse by indulgence in sardonic mirth at mankind's curiously persistent desire to reduce the population of the world.

ELECTRIC-FURNACE STEEL-CASTINGS IN CANADA.

"Iron Age" comments as follows in the issue of Aug. 25th on electric-furnace steel production in Canada:

> "One of the surprises of the abnormal course of steel production the world over this year is the performance of the electric furnace in Canada. Out of a total output of steel castings of 12,639 gross tons for the first half, 75.8 per cent or 9,585 tons was made in electric furnaces. On January 1 Canada had only 43 electric steel furnaces as compared with 356 in the United States. The best record ever made by American electric furnaces producing steel castings was in 1920 when almost 12.5 per cent of the total was electric. The best previous Canadian record was in 1919, when about 18 per cent of the total steel casting output was from electric furnaces. Of interest also is the fact that in June the Canadian electric steel ingot production of 1,353 tons was over twice that of the United States in July—575 tons. Even the American output for June, 1,476 tons, was but slightly in excess of the same month's output in Canada. Seeing that Canada has only about one-eighth as many electric furnaces as the United States, this performance is noteworthy."

There can be no doubt, as this periodical has on several occasions stated, that Canada will develop in the future a specialised role in the adaptation of electric power to iron and steel metallurgy, and more particularly to the production of alloy steels in the electric furnace.

Excepting only Nova Scotia, and possibly British Columbia, the combination of large iron-ore, limestone and coal deposits in proximity does not occur in Canada, and there does not appear to be much to be gained in Canada by attempting to emulate the United States in its unexcelled production of pig-iron and steel by means of the orthodox blast-furnace and open-hearth combination, so far as extremely large tonnages are concerned.

The United States, because of its unique possession of coal and iron resources, present in that country in quantity and quality not approached by any other

country, can always surpass the rest of the world in tonnage production of iron and steel, if it so desires.

Canada's place in the steel industry of North America would appear to be indicated first by its possession of much electric current, developed or developable from its water-powers, and the occurrence of a number of minerals suitable for making ferro-alloys.

The production of high-grade specialised steels, in moderate tonnages, would seem to be a sound ambition for Canadian metallurgists.

Such centres in Canada as Quebec, Montreal, Toronto, Hamilton and Winnipeg, consume, for railway, building and machinery construction and other purposes, a large amount of steel castings. By melting pig-iron and scrap in electrical furnaces a convenient method of making steel castings is suggested by the moderate cost of electricity available in very large quantity. There is also a not remote possibility of utilising the off-peak power for metallurgical purposes, which would be available at cheap rates should night-work at electric furnace installations become customary. The use of the electric furnace for such purposes all over Canada in a thousand and one local steel-casting industries is a fair possibility, and it is one that applies of course not only to ferrous metallurgy but to the non-ferrous foundries and the electro-chemical industry generally.

The same issue of "Iron Age" contains also an article by Joseph F. Shadgen, setting forth the secure place of the iron blast-furnace and the basic correctness of its wide application to the reduction of iron ores to pig iron, with which there will be very general agreement, always provided that the fuel and the ore available are of the kind approved by use and custom for blast-furnace reduction. But in Canada, as in other countries that do not possess such ores and are barren of coal fuel in large areas, the hope that electrical power may eventually be adapted to direct reduction of ores to iron and eventually to refined steel, arises from necessity to find a substitute for the iron blast-furnace.

In this connection, there are the best reasons to believe that Canadian metallurgists will find a variant of orthodox blast-furnace practice which will enable them to make fuel use of our abundant resources of hydro-electric power, and our deposits of titaniferous or lean iron-ores.

In other words, in a country where coal and kindly iron-ores are plentifully distributed, the direct process of iron-ore reduction by utilisation of inferior fuels and electric energy has only a mild and academic interest, but in countries where the ores are refractory or of low commercial grade and where coal is absent, the very reverse is the case. The probability is that electricity will be applied to iron and steel production in Canada in the future on a very large scale, and the necessities of our raw material situation will bring about the invention of processes that will give Canada a very distinctive place in ferrous metallurgy.

MR. GRAY ACCEPTS IMPORTANT POSITION.

Rarely does a publisher enjoy the services of a man of such excellent qualifications, both from training and experience, as are combined in Mr. F. W. Gray who has just resigned his position as editor of the Canadian Mining Journal and of Iron and Steel of Canada.

The fields of these two journals, while in a sense distinct, are yet so closely related that it is a distinct advantage to have the editorial work in the hands of a man who so thoroughly appreciates the various situations in both industries and can immediately make the most use of changes in conditions which he, as a leader and moulder of opinion, must be able to do if the journal is to function at its maximum efficiency. The Industrial and Educational Publishing Company takes this opportunity to express its very deep and hearty appreciation not only of Mr. Gray's exceptional ability but also his untiring, conscientious efforts to serve in every possible way, the best interests of Canada's mining and metallurgical industries.

Mr. Gray was born in England and came to Canada in 1904 when he entered the services of the Dominion Coal Company and remained with them for 14 years, holding the position of confidential assistant to various general managers. He received his early practical experience in the South Yorkshire coal mines under the late G. Blake Walker who was also recently President of the Institute of Mining Engineers. In 1918 Mr. Gray went with the Nova Scotia Steel and Coal Company where he remained until he became editor of the Canadian Mining Journal and Iron and Steel of Canada in 1919. Mr. Gray's work has brought him in constant contact with the steel industry and this with his studious disposition, has made him a master of many phases of that great industry. He is a thorough optimist with regard to the future of Canada's mining and metallurgical industries. He has made careful studies of Canada's fuel supply from every phase of that subject and has contributed many valuable papers to the scientific organizations to which he belongs, principal among which may be mentioned the Institute of Mining Engineers, Canadian Mining Institute, and the Engineering Institute of Canada, of which society he has been a council member.

Mr. Gray's outstanding ability has naturally brought him many opportunities for industrial positions and it was his good fortune to be offered the position of Assistant to Mr. D. H. McDougall, Vice-President of the British Empire and Steel Corporation.

The publishers of Mr. Gray's magazines because they have indeed acquired a character due to his inspiration and contact, wish him every success in his new work. Fortunately for those with whom he now severs his business connection, Mr. Gray will continue to reside in our community.

The John Inglis Company, Ltd.

A Long-Established Company with a Reputation Second to None for the Efficiency of its Plant and Machinery and the High Quality of its Products.

By A. R. R. JONES.

There are few better known manufacturing firms in Canada than the John Inglis Company, Ltd., of Toronto. For its reputation for the sound quality of its products—a reputation gained many years ago and steadily, and steadfastly maintained to the present day—is deservedly high and is Dominion-wide. It was over sixty years ago—in the year 1860, to be precise—that the foundations of the business were established at Guelph, Ont., where the manufacture of stationary engines and boilers was commenced by Mr. John Inglis, the father of the present president of the Company. About a quarter of a century ago, the business, by that time carried on under the style of John Inglis and Sons, was moved to Toronto. In 1903, the concern was incorporated as the John Inglis Company, Ltd., its present firm name.

The Company manufactures boilers, tanks, water towers, and all classes of steel plate work, marine, Corliss and pumping engines, centrifugal pumps and all descriptions of special machinery. Its general offices and works are situated on Strachan Avenue, Toronto. Mr. William Inglis is president and general manager, and Mr. Campbell Reaves, vice-president and secretary-treasurer, of the Company.

Unexcelled Plant and Machinery.

When the business was removed from Guelph to Toronto, it took up its quarters at its present location on Strachan Avenue. None of the original plant, however, remains doing duty to-day. The present plant is absolutely modern and up-to-date in every respect—in fact, a model of what a plant of this character should be. It is of brick and steel construction throughout, with a good deal of glass. It covers an area of about eight acres, and comprises two boiler shops—one of the these being, in size, 70 ft. by 400 ft. and the other 120 ft. by 400 ft.; a machine shop, 100 ft. by 400 ft. in size; a moulding shop; and a smith shop. As regards the facilities it provides— which include large additions recently made to take care of the growth of the business in boilers—and also as regards the well-planned and well-organized arrangement of its various manufacturing units, the plant is second-to-none.

In the various shops are gathered the latest and most efficient tools and machinery that it is possible to obtain, and these are operated by hydraulic, steam, pneumatic or electrical power, as the case may be. Continuous operation for many years has culminated in a system which for thoroughness, both of production and of inspection, is of the most admirable description. The staff—many of whom have been with the Company for a long period of years—consists of workers of the highest skill and efficiency procurable. It is such a staff and such an equipment, combined with a tested organization, both in the executive departments and in the works, that have conferred on the Inglis products the very enviable name that they enjoy.

Employees when Working at Full.

The number of employees, when the plant is working at its utmost—that is to say, both day and night—has been as high as 1,200 including those working as construction gangs. Of course, the business of manufacturing boilers cannot be said to have been at normal, or anything approaching normal, for the last seven years. During the war, industries, unless for some of the special purposes of war-time, were not permitted to put in boilers. Immediately after the war an avalanche of enquiries descended. But prices were higher then than the prices in war-time, and consequently purchases were postponed, in the expectation of prices coming down, though, as was evidenced by the large number of enquiries just mentioned, a big demand for boilers existed. That demand has not yet been supplied. Today prices are lower, and it is obvious that certain industrial concerns cannot much longer postpone replenishing their equipment.

Repairs are all very well and very necessary, so far as they go. Quite a number of boilers throughout the country must be reaching a stage when abdication in favor of a successor can no longer be postponed. It is not necessary, in this connection, to predict that good times are coming and that business will hum—though all of us hope, that they are and that it will. But what seems fairly plain is that many industries, albeit more lethargic that it is well for them to be, will have to get new equipment. The buying demand has, beyond question, reached an acute stage. Before long—probably before winter is on—it will be making itself apparent in action.

The Essentials Of All Boilers.

As has been indicated, the plant of the John Inglis Company is concerned mainly with the production of boilers. There are certain essentials that must be found in combination in any type of boiler of reliable quality. These essentials—or three of them—are safety durability and economy, and the entire output of the big plant on Strachan Avenue is always designed and worked out with the principle in mind that all boilers, to be successful, must combine these essentials.

The first essential is safety. This the Company secures by the design of the boiler, and by such selection, and distribution of materials as will resist all strains to which it is liable. In this the Company is distinctly mindful of the higher pressures called for by the exigencies of modern engineering.

Next, durability is a prime requisite in a boiler of any type. Indeed, durability in a boiler is, very largely, synonymous with safety. For unless a boiler is so designed and constructed as to stand reasonable and even extreme usage for a long period without detriment or deterioration, it contains within itself the seeds (so to speak) of failure. A boiler that is not durable is unworthy of being called a safe boiler. The Company is entitled to pride itself on the fact that, in this important matter of durability, the standard of the boilers that it turns out is, by common consent, unquestioned. Nor is the reason for their unquestioned durability any secret. To start with, they are properly designed. It is the very correctness of the design that eliminates the active cause that lead boilers to fail, to give out and to be condemned. Then they

are properly constructed. The most rigid and rigorous care is exercised in order to ensure that no defective or faulty material and no imperfection of workmanship enter into their construction. In addition to the correctness of design and the tried and tested quality of the materials used in the construction of the Company's output of boilers there are the special facilities it possesses for turning out work of unexcelled quality which have already been noted.

Finally, the boilers turned out by the Company are economical in operation. This is a point which, in these days of high fuel costs, no manufacturer or executive of an industrial plant of any kind can afford to disregard. For it is just here, that correctness of design and perfection of construction reap their own reward,—it is just here that they yield dividends to the user. The proper proportion of grates to heating surface, of glue and chimney areas to each other, combine to secure the required power from the least amount of coal.

A Word About the Material.

Mention has been made of the care exercised to ensure that no defective material enters into the construction of the Inglis boilers. At this point a more specific word or two on this question of material may appropriately be said. The proportions of plates, rivets and tubes used are such as are expressly designed to fit the boilers for use at high pressures. In this connection it should especially be noted that cast iron, malleable iron or castings of steel form no part of the boiler exposed to steam or water pressure are of wrought steel or wrought iron. The material of which the boilers are built is absolutely the most suitable for its purpose that it is possible to obtain. The plates are from the best known makers and are of open hearth homogeneous steel, with a tensile strength per square inch of section that afford, a large margin on the side of safety. All parts of the boiler resisting the pressure of steam or water, except the tubes, are made of these plates. The rivets and tubes are from standard makers.

There are three classes of boiler made by the John Inglis Company, Limited. First, there is the return tubular boiler. These tubular boilers are both ordinary and firebox. All these boilers are built of steel and tested to 75 lbs. pressure, but the safety valves are set at 15 lbs. pressure.

Then marine boilers of all kinds are constructed by the Company. Among them may be mentioned the large Scotch marine boiler and the small Scotch boiler for tug boats. These boilers are built with one, two, three of four furnaces to suit requirements, with natural draft or forced draft fronts, and breechings, air heaters and funnels are designed to meet conditions.

A Special Water-Tube Boiler.

Thirdly, the Company, recognizing that the increased demand for the water-tube boiler made it advisable to add that type of boiler to its output, obtained the sole Canadian right to manufacture the Erie City water-tube boiler. This boiler presents many special features, alike in construction and in operation. The effect of these is to render the results obtainable from its use far superior to those obtainable from a water-tube boiler of the ordinary type.

In adopting this design, the Company did so in the conviction that it would take the highest rank as a means of obtaining power from fuel, as regards efficiency. Efficiency, in this connection, is not to be measured solely from the coalpile, but the term is used in its broadest sense as applied not only to the product of steam at a given rate, but also as taking into consideration capacity and freedom from repairs, and from unusual expense in keeping clean. The claim made for this boiler is that, at the end of a year or any extended period, it will not only have furnished more steam per lb. of coal, but also will stand charged with less expense for repairs and delays than any other water-tube boiler now being offered in the market.

Each of these boilers is tested in its completed condition to 225 lbs. hydraulic pressure in the presence of a Government or Inspection Company's representative. It is not shipped piecemeal, but complete, ready for being placed in position and bricked up, thus avoiding a multiplicity of joints and the assembling of innumerable parts on arrival at its destination.

Contribution to War-Time Effort.

Before the war the John Inglis Company Ltd., had been engaged, making in addition to its engines and boilers for use in industrial establishments, a considerable number of marine engines and boilers. When the war broke out the Company, as befitted one of Canada's outstanding manufacturing concerns, was prepared to take a prominent part in the country's war-time effort by diverting its manufacturing facilities to war work. Accordingly, it started in on the manufacture of shells. But it had not gone very long on this class of work before it was requested to build engines and boilers for the Canadian Government Merchant Marine service. For this kind of work, it was preeminently fitted, alike by its equipment and by its experience in the construction of marine engines and boilers. It devoted itself whole heartedly to the production of engines and boilers for the purposes required, and its efforts were crowned with success. It turned out a large number of boilers and engines for the Canadian Government Merchant Marine. Among much other work of this nature, it constructed, for four 8,100 tons freighters, triple expansion marine engines of 3,000 horse-power.

AMPHIBIAN TANK FAILS.

The latest British engine of war, an amphibian monster in the form of a tank which is capable of travelling on land as well as on water, sank during experimental tests, the three officers on board escaping.

During the tests the tank, after crawling along the ground, entered the River Thames, where it travelled about 300 yards on the water and then filled and sank.

The monster is an armored tank, equipped with caterpillar wheels and also paddles. Recently it successfully carried out water tests at Woolwich Arsenal.

INTERNATIONAL HARVESTER CO. TO MAKE MOTOR-TRUCKS AT CHATHAM, ONT.

Announcement is made at Hamilton by the International Harvester Co. of Canada, Ltd., that the Chatham works of the company are being made to take over the manufacture of motor trucks. Chatham was selected by the company because it was the home of the waggon and sleigh factory of the company.

M. J. Loughlin, manager of the sales department of the company, says that from the standpoint of speedy service alone the new factory is a necessity. "Chatham has been selected," he says, "because it is already the home of our waggon works, and that will enable the company to begin turning out Canadian-made trucks in the shortest possible time."

The World's Chief Deposits of Titaniferous Iron

By FRANK LYMAN MacCALLUM, Kingston, Ont.

Titaniferous ores of iron are at present among the most neglected of our resources. But they were not always so, nor can they continue so, indefinitely. At longest, they may have to lie idle until growing scarcity of the ores now in vogue balances the extra cost and difficulty of smelting titaniferous ores by present methods. On the other hand, the discovery of a favorable method for their reduction would quickly make them available, and might easily result in their supplanting some of the ores now used.

It is the custom to class as "titaniferous" only ores which contain over two or three per cent of titania (TiO_2). When the titania and iron-oxide are about equal, the resulting mineral is called "Ilmenite" (FeO, TiO_2), while "Rutile" is practically pure titania in its mineral form.

Dikes, lenses and sands make up the three chief varieties of ore-body. The first two are the result of differentiation in gabbro—and anorthosite-forming magmas. The heavy iron oxides, having settled to the bottom of the molten intrusion, might either crystallize there in lenticular sheets, or be forced by a "squeze" into cracks in the surrounding areas, giving rise to dikes. The third mode of occurrence depends on the weathering of these and kindred rocks, and the concentration of the particles of resistant magnetite in beds of titaniferous iron-sand.

The lenticular deposits, being local enrichments of the gabbro or anorthosite, grade out by degrees into the surrounding barren rock. Contacts of dikes, on the other hand, are sharply defined.

For more than a generation, there has been such hostility to titaniferous iron ores that once a deposit was known to belong in that classification it was generally abandoned,—at times without being even recorded. For this reason, information is meagre and contradictory, and the estimates in the following list are seldom based on more than surface indications. They are quoted in order to convey some idea of the vast supplies of ore—much of it such as would yield iron of the highest quality—lying undeveloped because of their titaniferous character.

A second paper will describe the promising method for overcoming the difficulties peculiar to these ores that has recently been evolved at Queen's University, Kingston, Ontario.

United States.

Iron Mountain, Colorado.

In the Southern part of Freemont Co.

The rock is a gabbro containing, according to magnetic surveys, some seven small dikes of magnetite, from 1 to 50 feet wide and with a total length of 1,800 feet.

It averages 48 per cent iron and 13 per cent titania.

Estimated Tonnage: — Some half-million tons per hundred feet of depth.

Iron Mountain, Wyoming.

Twenty miles north-east of Laramie.

This is said to be the largest deposit in the United States. It is composed of three dikes cutting across anorthosite, and themselves cut by intrusions of granite. The main dike is one and a quarter miles long and 40 to 300 feet wide; the second dike is two miles long by 6 to 20 feet wide and the third is 300 feet long by 10 to 30 feet wide.

The ore averages 51 per cent iron and 22 per cent titania.

Estimated Tonnage: — Fifteen to twenty million tons per hundred feet of depth.

Nearest Railway: Nine miles.

Shanton Ranch, Wyoming.

Five and a half miles south west of the Iron Mountain deposit and similar to it in composition.

The main body is 1,000 feet long and 20 to 80 feet wide.

Estimated Tonnage:—Six hundred thousand tons per hundred feet in depth.

Minnesota.

The ore-bearing gabbro extends for 125 miles north east from Duluth, with a maximum width of 25 miles. It contains numerous local enrichments, in which the grains of magnetite may form any proportion up to 90 per cent of the rock.

The district around Mayhew (or Iron) Lake, near the International border, is the best known and perhaps the most important. The masses of ore are extremely irregular and contain large admixtures of gabbro material. They attain a depth of several hundred feet.

The ore here may be averaged at 49 per cent iron and 11 per cent titania.

Sanford Hill, New York.

On Lake Sanford, at the headwaters of the Hudson River.

The second largest body of titaniferous magnetite recorded in the United States. It occurs as a large mass of ore in anorthosite. Magnetic surveys and diamond-drilling give the main orebody as at least half a mile by (perhaps) 1.3 miles with depth proven to 400 feet. (Limit of drilling.)

The ore averages 58 per cent iron and 16.3 per cent titania.

Estimated Tonnage:—Fifty million tons easily mined.

Nearest Rail:—Thirty miles.

Several smaller bodies occur in the vicinity.

Iron Mine Hill, Rhode Island.

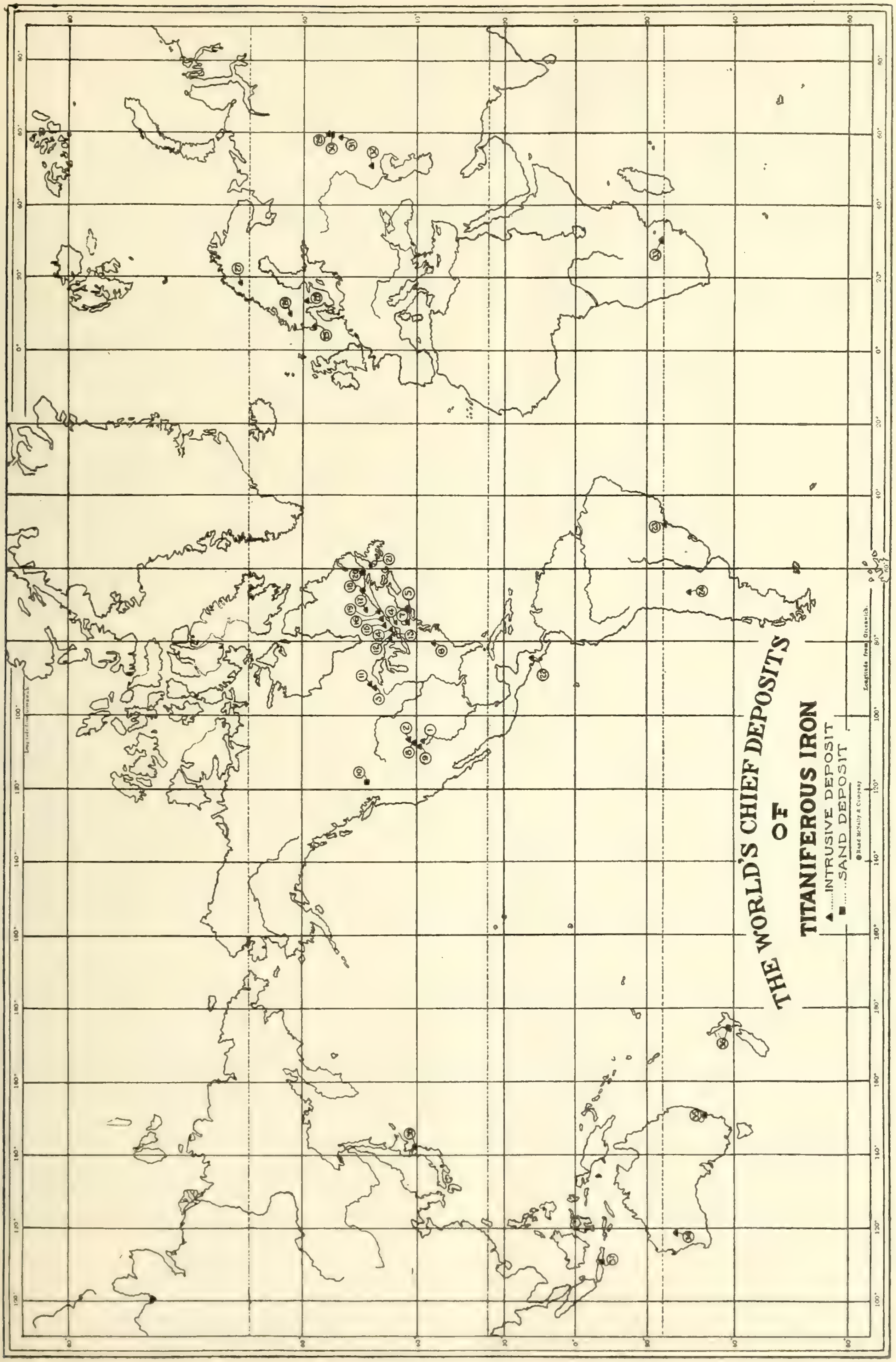
In the north-east corner of the State.

This is a mixture of olivine and magnetite which has been intruded into gabbro. The orebody, according to magnetic observation, is 1,200 feet long by 500 to 600 wide. It is, however, quite lean, averaging only 33.4 per cent of iron with 9.75 per cent of titania. On the other hand, it is very low in phosphorus and sulphur, and contains vanadium.

Other Deposits.

The deposits of titaniferous iron occurring in the Piedmont and Appalachian regions of North Carolina are described as small and irregular and of doubtful value.

In New Jersey, the deposits with a considerable titanium content are said to be none of them large.


THE WORLD'S CHIEF DEPOSITS
OF
TITANIFEROUS IRON
▲ ......INTRUSIVE DEPOSIT
■ ......SAND DEPOSIT

In Colorado, at Caribou Hill, Boulder Co., the ore is medium grade, with only small lenses.

That part of the deposit at Cebolla Creek, Gunnison Co. Colorado, which is titaniferous, occurs as numerous small, scattered segregations, making any large scale development impossible.

Canada.

Burmis, Alberta

Not far from Blairmore, in southern Alberta.

This is an old beach of consolidated, black magnetic sand, which has been exposed here and there for eight miles by means of open cuts. The ore is interstratified with coarse, light sandstones. At the north end of the deposit there are at least three iron beds—one with a thickness of 10.5 feet—fairly uniform in character.

Seine Bay and Bad Vermillion Lake, Ontario.

Five miles from Mine Centre, and nine miles from the Minnesota border.

This is a 12 mile range, consisting of overlapping dikes, bordered on either side by masses of low grade ore from 15 to 200 feet wide and extending continuously for the length of the range. These masses grade out into gabbro. Diamond-drilling to 600 feet has proved them to be uniform in depth. Phosphorus and sulphur are quite low except in occasional pockets.

The ore averages 50 per cent of iron and from 10 to 20 per cent of titania.

Estimated Tonnage:—Twenty to thirty million tons per hundred feet of depth.

Nearest Railway:—Four miles.

Pine Lake, Ontario.

In Haliburton Co., eighty miles north of Lake Ontario.

This is a lenticular deposit of magnetite in gabbro, exposed over an area of 1,800 by 140 feet, and rising 90 feet or so above the general level of the country.

The ore averages 52 per cent of iron and 13.3 per cent of titania.

Estimated Tonnage:—Three million tons per hundred feet of depth.

Orton Mine, Ontario.

In Hastings Co., forty miles north of Lake Ontario.

This is a ridge of gabbro over 1,400 feet in length by 60 to 160 feet wide, rising about 100 feet above the level of the surrounding country. It contains numerous lenses of magnetite, of considerable but undermined size.

The ore averages 50 per cent of iron with 10 to 15 per cent of titania.

Tonnage is obscured by overburden, but is probably somewhat similar to that of the Pine Lake deposit.

Chaffey Mine, Ontario.

In Leeds Co., about one mile from Newburgh.

This comparatively small body is interesting from the fact that fifty years ago, while magnetites were still acceptable, the ore was exported to United States blast furnaces; 6,000 tons being sent to Pittsburgh in the years 1858-9 and 11,000 tons to Cleveland, Ohio, in 1870-71. Its titaniferous character does not seem to have been considered objectionable.

It carries 50.2 per cent of iron and 9.8 per cent of titania.

Two deposits of probably no great extent, but easily accessible and close to industrial areas are those at Desgrosbois and Grondin, Quebec. The Desgrosbois occurrence is in Terrebonne Co., 65 miles north of Montreal on the line of the C.P.R. The rock is anorthosite and the ore runs about 50 per cent of iron and 15 per cent of titania. The Grondin deposit is in St. Maurice Co., six miles from the huge hydro-electric plants of Shawinigan Falls. The rock is a gabbro and the ore runs 41 per cent of iron and 9 per cent of titania.

St. Charles, Quebec.

On the north bank of the Saguenay River, in Chicoutimi Co.

The latest examination of this deposit shows it to be an aggregation of lenses in gabbro in the midst of a huge anorthosite intrusion. The ore extends over 2,200 feet with a maximum width of 600 feet.

It carries 45 to 50 per cent of iron with 20 per cent of titania.

Estimated Tonnage:—In sight above the river level is twenty-five million tons.

Other occurrences in this area, such as those at Kenogami and Ile d'Alma, are comparatively unimportant.

Seven Islands, Quebec.

In Saguenay Co., nearly opposite the island of Anticosti.

This comprises a number of irregular masses of titaniferous magnetite on islands at the mouth of the Rapide River and cutting the river for four miles above its mouth. They are in gabbro, and of unknown, but considerable extent.

The pure parts carry 50 to 52 per cent of iron and 18 per cent of titania.

Estimated Tonnage:—Four-hundred-thousand tons of rich ore, and probably very much more.

St. Urbain, Quebec.

In Charlevoix Co., near Baie St. Paul, sixty miles down the St. Lawrence from Quebec City.

The deposit is made up of masses several hundred yards in extent and over ninety feet thick, consisting of almost pure ilmenite with, in places, an admixture of rutile. This deposit is more properly a source of titanium than of iron, the only others on this continent of equal prominence being those at Ivry, Quebec, and Amherst-Nelson Counties, Virginia.

Ivry, Quebec.

In Terrebonne Co. three miles from the Desgrosbois deposits. The highly magnetic zone covers an area of 700 by 120 feet.

The ore runs about 47 per cent of iron with 30 per cent of titania.

This deposit is thought to be of greater size and commercial importance than the similar one at St. Urbain.

St. Lawrence Sands, Quebec.

Along the north shore of the St. Lawrence from 200 to 530 miles below Quebec City are extensive magnetic sand deposits of which the most noted are near the mouths of the Bersimis, Moisie and Natashkwan rivers. These are more spectacular than important, for the maximum depth is but fifteen feet and the iron content averages only eight or nine per cent. It is estimated that three miles of the very best beaches would produce 5,800,000 tons of sand, yielding 500,000 tons of concentrates carrying 67 per cent of iron and about 12 per cent of titania.

Newfoundland.

From the western part of the island are reported immense deposits" running as high as 65 per cent of iron and with 5 to 16 per cent of titania and free from sulphur and phosphorus.

Nicaragua.

"Large deposits" of titaniferous iron ore are reported from the central chain of mountains.

Brazil.

Jacupiranga, Sao Paulo.

Near the lower course of the Ribeira River, about thirty miles from the coast.

This famous ore body appears as a series of low hills whose predominant rock consists of dark schists in inclined layers. It covers a rectangular area of between eleven and sixteen square miles.

The ore carries 20 per cent of titania.

Argentine Republic.

From the Sierra de Ancasti, south-west of Catamarca is reported a chain of ore-bearing hills of great promise. The ore is in diorite and carries 48 to 52 per cent of iron and 17 per cent of titania.

Singewald and Miller, however, describe the bodies of titano-magnetite as "narrow".

Norway.

Ekersund and Soggendal.

On the south-west coast, six or eight miles apart.

At Soggendal the ore is in lenticular masses while at Ekersund it is found in dikes, anorthosite being the country rock in both cases.

The ore contains 38 to 40 per cent of iron and 38 to 40 per cent of titania. This is therefore an ilmenite deposit.

Estimated Tonnage:—Probably ten million tons or over.

Selvaag.

A deposit with an area of 100,000 sq. meters. (25 acres).

It contains 30 to 35 per cent of iron and 3 to 4 per cent of titania.

Sweden.

Ruoutevare.

Ten miles north of the village of Kvikkjok, within the Arctic Circle.

This deposit is composed of irregular, elongated masses of ore in highly-metamorphosed anorthosite.

The orebody covers some thirty three acres and its depth is believed not to exceed some tens of meters.

The ore averages 45 to 50 per cent of iron with 10 to 12 per cent of titania.

Estimated Tonnage: Nineteen million tons of such ore.

Taberg, South Sweden.

This is a segregation of magnetite in olivine-hyperite closely resembling the unusual deposit at Iron Mine Hill, R. I.

The orebody forms a hill 409 feet high, 472 yards wide and 944 yards long.

The ore carries 32 per cent or less of iron and 7 per cent of titania.

Estimated Tonnage: Fifty million tons at a depth of only fifty meters.

Russia.

Nasjamskija Gory, Middle Urals.

The deposit consists of three, parallel, veinlike bodies, the longest of which has been followed for a mile and a quarter and the shortest for over a half a mile. They average perhaps eight feet in width and three hundred in depth.

The ore runs 53 to 63 per cent of iron with 4 to 18 per cent of titania.

Estimated Tonnage:—Not less than 4,170,000 tons.

Magnitnyj Chrebet, Urals.

On the Kopanka River in the Satinskaja Datsha west of lake Sjurat-Kul.

The ore runs 35 per cent of iron with 13 per cent of titania.

Estimated Tonnage:—Over one million tons.

Mt. Magnitnaja, Urals.

In the Schaitanschen Datsha.

This is an intrusive deposit in gabbro with an area of some 1,681 acres.

It runs 61 per cent of iron and 5 per cent of titania.

Estimated Tonnage:—At least 25 million tons, and probably twice that amount.

Tyr Aggr.

In the eastern part of the Khirgiz Steppes.

The ores carries 55 per cent of iron and 15 per cent of titania.

Transvaal.

Bushveld.

The orebodies form a belt of huge, lens-shaped deposits, ranging in thickness up to over half a mile, enclosing a tremendous laccolite which covers an area of some 25,000 square miles.

The ore carries 47 per cent of iron and 2 to 3 per cent of titania.

Australia.

Gabanintha, West Australia.

The orebody forms a low ridge 30 to 40 feet high, 50 to 100 feet wide and 2.5 miles in length.

The ore carries 52 per cent of iron and 12 per cent of titania.

Estimated Tonnage:—Ore in sight above the plain, over 1.5 million tons.

Clarence Town, New South Wales.

The stratified sandstones which contain the ore are very much disturbed and too irregular to have much value but are close to the State's most productive coal fields.

The ore averages 43 to 46 per cent of iron with 7 to 11 per cent of titania.

Estimated Tonnage:—Over two million tons.

New Zealand

Taranaki.

On the north island, particularly at Patea and New Plymouth. These are deposits of iron sands which occur at intervals along the coast for over eighty miles.

They contain over 50 per cent of iron with 9 per cent of titania.

Estimated Tonnage:—Many million tons.

Japan.

Kunohe-Gori.

In the province of Rikuchu.

Mining was carried on here for centuries under the protection of a feudal lord. The ore is a titaniferous iron sandstone which covers a strip 12.5 miles long by 3.7 miles wide to a depth of 20 feet.

It carries not less than 10 per cent of iron.

Java.

Along the coast are accumulated sands estimated at "many million tons", with an average content of 50 per cent of iron and 15 per cent of titania.

The Mooted Iron and Steel Industry in British Columbia

ROBERT DUNN, Victoria, B.C.

Much has been said of the possibility of the establishment somewhere in the Pacific Northwest of an iron and steel industry. That the enterprise some day will be realized is not doubted but British Columbians of the present generation may be excused if they are beginning to doubt whether it will come in their time. The offering of a bounty on pig-iron produced within the Province and the proffer of all assistance within its power by the provincial administration has given rise to many reports of imminent action by British and by American capital but nothing definite has yet happened.

There is plenty of magnetite ore in the most westerly of Canadian provinces. It exists in large deposits, easy of transportation, on the west coast of Vancouver Island, on some of the islands of the Gulf of Georgia, on Queen Charlotte Island, and at different points along the Coast. Of hematite it is not posible to speak with as much assurance. There are considerable deposits, however, in the Crow's Nest Pass District, Eastern Kootenays, notably those of Kitchener, situated on the Canadian Pacific Ry., and Sand Creek.

The raw material, therefore, may be said to be available. Other essential resources abound. Probably no other part of the world is so bountifully supplied with unharnessed water-power. Coal is present in quantities that it would be presumptuous to attempt to estimate. If the fields of Vancouver Island, of the great Groundhog Country to the North, of the Nicola-Princeton area, and of the Crow's Nest Pass District were to become exhausted, an eventuality that would require the most extensive exploitation over decades, there still are the immense beds of the Province of Alberta to the immediate East. All the fluxes needed are at hand and conditions generally are everything that could be desired. Capital, however, is lacking. British Columbia beckons but, thus far, the men of dollars are timidly unresponsive. Of those who would have the government guarantee bonds and grant concessions beyond reason there are many, but the enterprising business man, with the large financial backing necessary to put through such a project in the way that it must be handled to be economically successful, has not stepped forward. The "welcome sign" remains without an acceptance.

And what of the market? Will it be suggested that the possibilities of the field that exists in the western States from California north are negligible? Is it not clear that the western Canadian provinces are showing a like development in point of population and of industry? The opportunities of this great expanse of country, which may be considered as a whole in this connection regardless of the 49th Parallel and what it signifies, cannot be much longer overlooked by the East. Then there is the Orient to be looked to as a trade outlet of importance. In the Western States and in Western Canada there is a profound conviction that the early future is to see a wonderful expanion of mercantile traffic over the Pacific to and from the ports of the Far East and the portals of western civilization. If the American West is going to be in a position to seize the opportunties that the future promises in this respect it certainly is imperative that the basic industry, and the industries directly springing therefrom, should be established without further loss of time.

On the point of the market an interesting report to the Department of Industries of British Columbia from Mr. Nichol Thompson, of Vancouver B.C., who was appointed specially to make a thorough investigation, has been published recently. Some of Mr. Thompson's observations bear so directly on the point under discussion, and his researches were made so lately, that they are well worth repeating.

"There is a market on the Pacific Coast for 2,000,000 tons per annum of iron and steel" he declares.

"This is the aggregate consumption of all grades, including tank, ship and boiler plate, merchant bar, tool and mining steel, structural steel, shapes and angles, and also light rails. Any one plant capable of turning out all these grades and sections of steel would require tremendous capital outlay in rolls and other equipment. If blast-furnaces were established here and a supply of

Warner's Pass.

the various grades of pig-iron assured at reasonable price, subsidiary companies would undertake the manufacture of the different grades and sections of steel to suit the market.

"There is, beyond a doubt, a local or domestic market on the Pacific Coast, from Los Angeles to British Columbia, for foundry pig-iron alone of at least 1,000 tons per day; and if produced at anywhere near the cost of steel—$27 to $30 per ton—I think I can safely say there is a market for 2,000 tons per day. There are five scrap-mills in California, at San Francisco and Los Angeles, with monthly output of 27,000 tons, and one in Washington, at Seattle, with present output of 4,000 tons per month. These mills, turning out over 1,000 tons per day of merchant bar from steel scrap, would use at least 40 per cent. pig-iron if they could get it; in fact, Mr. Denman, of the Southern California, and Mr. Botchford, of the Columbia Steel Mills, informed me they would undertake, on behalf of the five California mills, to contract for 500 tons of pig-iron a day. The cast-iron foundries in Washington, Oregon, California, and British Columbia will easily consume 1,000 tons per day. Undoubtedly the time is opportune and there is every inducement for capital, properly organized and managed, to get in on the ground floor with the nucleus of this basic industry.

"In addition to the local market, there is an export market looming large in the future development of the Orient, Australasia, and the Isles of the Pacific, and the west coast of Mexico and South America. The present export through British Columbia ports is now practically nil, because of the fact that Canada does not manufacture nearly sufficient for domestic requirements and at present is a large importer of iron and steel. There is, however, a very different story to tell regarding the exports through the ports of Seattle, Tacoma, Portland, San Francisco, and Los Angeles; though even here it is somewhat difficult to obtain the correct data, as many of the items are not listed by weights but rather by value, or perhaps by number and value. In point of value this export trade through United States Pacific Ports in 1918 amounted to approximately $100,000,000. The tonnage of pig-iron, steel billets, ingots, blooms, rails, and structural iron and steel in the same year totalled 1,000,000 tons and $68,000,000 of the total valuation of exports, the balance consisting of machinery or iron and steel. It is interesting to note in this connection that for the ten months ending April 30th, 1920, approximately $14,000,000 in steel rails were shipped to Pacific Ocean countries, and that this item represented 60 per cent. of the total United States exports in this commodity. These rails were mostly smaller and medium sizes, the percentage above 60 lb. being almost negligible.

"Heads of the various iron- and steel-working plants of the Pacific Coast in Washington, Oregon, and California, who were interviewed, and gave information freely regarding their plants, consumption, etc., were practically agreed that the establishment of blast-furnaces and a steel plant on the Pacific Coast was a necessity. The time was opportune and the project would be warmly welcomed. They said they would gladly co-operate with owners of mills producing merchant bar from scrap in California, and offered to make a contract at once for 500 tons per day of pig-iron as soon as blast-furnaces were started on the Coast. All gave numerous instances of trouble and difficulties through congestion of orders and lack of cars for transportation and delivery. Prominent mill-owners in California told of investigations made by them with a view to establishing a blast-furnace, but coking-coal supplies in Washington were found unsatisfactory, and they would welcome the establishment of a Coast plant. Washington iron and steel workers said that in 1916 a number of them, including also the manager of the Bethlehem Steel, offered Mr. Piggott, of the Pacific Steel Company, a contract for 250,000 tons of ship-plate at the same price paid in the East, but he could not undertake the work. All agreed that an iron and steel plant on the Pacific Coast would not only be a distinct advantage, but profitable to the company undertaking it, the raw materials being assured—there was no difficulty about the market—but would also be of great aid to those now engaged in the iron- and steel-working industries of the Coast, and would stimulate many new industries and additions to present industries; and, moreover, would do much for the general upbuilding of the Pacific Coast.

"There are a large number of metal-working plants on the Pacific Coast which at present, in addition to other material, consume approximately 1,000 tons of pig-iron and would use much more if it was procurable at a reasonable price.

"Six plants, five in California and one in Washing-

Looking down Red Creek in Taseko Valley.

ton, are engaged in manufacturing steel in open-hearth furnaces, producing 3,000 tons per month about 65 per cent merchant bar, $\frac{1}{4}$ to 4 inches, in rounds, squares and flats and reinforcing bars, $\frac{3}{4}$ to $1\frac{1}{4}$ inches, and the balance angles up to 6 inches and beams and channels up to 8 inches. These mill now use about 90 per cent scrap and 6 per cent pig iron, and would use 40 to 50 per cent. pig-iron if obtainable.

"California has twenty-one iron-foundries, employing 2,300 men, using 30 to 50 per cent. pig-iron, the balance scrap, consuming about 4,500 to 5,000 tons of pig-iron per month. They could use at least 200 tons per day of pig-iron. The five steel-making plants are willing to enter into a contract at present for 500 tons of pig-iron a day. Other metal-working plants, such as the Bethlemen Shipbuilding Corporation, now using 150 tons pig-iron, 200 tons of blooms and billets, and 50,000 tons of plates and shapes per annum; Baker Iron Works, of Los Angeles, engaged in fabricating structural steel for bridge and building purposes, with engineering-works machine-shops, etc., would increase the market.

"In Washington data compiled by the Seattle Chamber of Commerce shows present consumption of pig-iron would be about 75,000 to 100,000 tons a year. The only plant now manufacturing steel in open-hearth furnaces is the Pacific Steel Company, with normal output of 4,000 tons per month. This plant uses mostly scrap and a small percentage of magnetite from a deposit owned by the company on Texada Island. The engineering, forging, and manufacturing plants, car wheel and axle, and other plants and foundries and machine-shops consume a considerable. amount and offer a growing market for pig-iron.

"Oregon has thirty-five iron- and steel-working plants, of which thirty-three are foundries; the consumption of this State at present being estimated at 100,000 tons per year.

"British Columbia has seventeen plants, ship-building yards, engineering and other works engaged in iron- and steel-working idustries, in addition to a number of foundries, machine-shops, and smaller plants, now consuming 3,010 tons of pig-iron and offering a market for much more if available; 6,050 tons of scrap cast-iron; 1,190 tons of scrap steel; 163 tons of billets; 1,825 tons of merchant bar; 15,270 tons of ship, tank, and boiler plate; 8,715 tons of angles and shapes; 2,500 tons of rivets and sivet-bars; and 200 tons of structural steel a year.

"While I have endeavoured to get as near as possible to the actual consumption of pig-iron in British Columbia, I do not think the returns given by the various foundries offer a fair criterion as to what the actual consumption would be if a blast-furnace plant was in operation in the Province and pig-iron procurable as a result at a reasonable price. The abnormal amount of cast scrap used is evidence of this. The increase in the cost of pig-iron since 1912 from, let us say, an average of $30 to over $70 compelled foundrymen to use scrap wherever possible.

"The combined consumption of pig-iron and cast scrap in 1920 was approximately 9,060 tons.

"According to data furnished by the Minister of Customs, Ottawa, the quantity and value of pig-iron imported into British Columbia for the fiscal year 1912 was 7,648 tons, valued $102,736; this value, of course, being the f.o.b. price, Liverpool, and not the selling-price here. If British Columbia could use practically 8,000 tons of imported pig-iron in 1912, it is reasonable to conclude that, owing to the increase in the industrial life of the Province, the requirements of pig-iron should be at least 15,000 to 20,000 tons per annum; and that bears out my own personal observation and conclusion that present consumption of pig-iron in British Columbia will approximate 50 tons per day. When it is considered that 1910 the consumption of pig-iron was only 2,000 tons the increase is remarkable.

"The total quantities of the products of iron and steel imported in British Columbia for the fiscal year ending March 31st, 1912, was 58,674 tons, the invoice value of which was $1,988,701; for the nine months ending December 31st, 1917, the value of the principal items of iron and steel entered for consumption through ports of British Columbia was: Dutiable, $2,988,159; free, $1,664,576; a total of $5,652,735. This shows a great increase in consumption of products of iron and steel during the past five or ten years, and taken in conjunction with the greater market to the south, and across the Pacific to the Orient and Australasia, forms an interesting basis for any one contemplating establishment of an iron and steel industry in British Columbia."

Limonite of the Taseko.

To revert to the question of British Columbia's native resources it was thought that the Taseko Valley iron-ore deposits would prove another reserve of great importance, the reports received from that section over a year ago having been exceedingly favorable. Hon.

Camping Ground.

Wm. Sloan, the Minister of Mines, accordingly had a field party outfitted in order that the zone might be thoroughly explored and its resources definitely ascertained. F. J. Crossland, mining engineer and geologist, was in charge and his report, an interesting document, has been published in the annual report of the Minister of Mines for 1920.

While Mr. Crossland's conclusions are not favorable as to the economic importance of the deposits, the ore tonnage being insufficient to warrant the installation of the necessary equipment to mine out the ore beds uder existing conditions, what he says in his description of geology of the district and of the character of the ore beds is rather a striking indication of the mineral richness of the region.

"Everywhere in this area (Taseko River Valley, Clinton Mining Division, B.C.) the iron-ore deposits consists of bedded limonite, a variety of bog-iron ore, occurring mostly in platy layers of varying thickness" he reports. "Covering some of the deposits are layers of disintegrated brown earthy limonite which have weathered to a crumbly pulverulent mass sometimes a foot thick, and ranging in size from a grain of powder to fragments an inch or two across. Below this loose covering the ore is found compact, with a solid laminated structure paralleling the slope or floor of the basin, on which it has been laid down in successive layers during the transformation of the iron sulphates in the surrounding rock.

"The deposits, being of secondary origin, are formed by the general circulation of water through iron-bearing rocks, often absorbing a vegetable acid which assists the water to take up iron in solution. Ferrugin-nous minerals are amongst the first and earliest that fall a prey to alteration; carbonic acid in the water aids in dissolving out the iron in the surrounding country-rock. The organic acids play a part, and the resulting alteration of the iron affords sulphuric acid and ferrous sulphate which readily enter into solution by the decomposition caused on the admission of air; ferric hydrate soon forms. Evidence of this process is borne witness to by the limonized roots, twigs, and fir-needles found in the ore-beds that have been wholly or partly transformed to limonite.

This ferric hydrate — i.e., limonite ($2Fe_2O_3$, $3H_2O$) — is formed as a red scum which, following the law of gravity, is carried to the basins, where it gradually accumulates. Theoretically, therefore, the flatter the pitch the greater will be the quantity deposited, and in this respect much depends on the physical features of the floor of the original bed-rock to account for its varying thickness even over a small area covered by an individual deposit. On all the surrounding hills, the rock-masses of which are composed of cherty ironstone and rhyolite impregnated with pyrite, rusty impregnated water can be seen percolating down the hillside, carrying the light films of limonite which accumulate in the form of bog-iron ore-beds in the basins below.

"The number of deposits herein described consist of eight widely separated groups or sections, each of which is made up of a number of ore-beds. The analyses of samples taken in different ways with a view to arriving at the average character and quality of the ore agree very well as to the homogeneity of the different deposits and emphasize the purity of the iron ore."

Of twenty-seven samples assayed there was a range in the returns between 44.60 and 58.50 per cent. iron.

"When Mr. Crossland refers to 'existing conditions' he means the comparative inaccessibility of the country, the lack of transportation facilities, etc. It is to be remembered that the section in question, an area of roughly about fifteen square miles embracing the upper part of the valley of the Taseko River, lies between the coast range of mountains and the interior plateau and is almost enclosed by mountains, the peaks of which reach elevations between 7,000 and 9,000 feet.

"Some excerpts from a diary of a member of the exploration party perhaps will be of interest as showing what the prospector has to contend with in this part of British Columbia.

An open cut on iron deposit,
Taseko River.

"It was decided on the trip in 'he says' to follow the left fork of Gun Creek to Warner's Pass, altitude 8,000 feet. Difficulties were encountered on reaching the snow in getting the horses through. — After a lot of trench digging the horses reached camp and tents were pitched for a stay of two weeks on Red Creek, the first limonite deposit, at an altitude of 6,200 feet.—Lots of ptarmigan in sight, just beginning to turn brown on head and neck in change from winter to summer plumage. The male birds start chackling at sunrise and all day long utter their peculiar 'go back' cry. Quite a few found their way into the mulligan pot.

"After nine weeks' work ascertaining tonnage of three deposits went on hunting excursion with party. Lots of snow but no deer. A few grouse and plenty of groundhogs. At noon a very rare sight was seen, three timber wolves apparently on the hunt and organized.

They were spread out abreast to run down anything that might be put up. They were on a ridge to the south which was clear of snow. Too far away for a shot.

"Week later set out hunting in direction of Taseko Lakes, which are at an altitude of 4,200 feet. Near the lakes it became quite warm with plenty of grass and myriads of mosquitos. A big buck was killed. On the way up rest was enjoyed on top of high bluff near the old Chilcotin Indian trail. We had splendid view of big stretch of country, tremendous expanse of mountain on all sides and below the virgin valley, rich in its abundant verdure with the lakes glimmering in its centre. On the Whitewater river could be seen a colony of beavers going back and forth busily at work on a dam. On starting up-hill a pair of goats and some kids were sighted on a ledge. We watched without disturbing them as we were above and the wind blowing in the other direction.

The writer tells of switching camp several times, of prospecting a number of other deposits, and states that the first fall of snow occurred on the 28th of August. The second week in September it snowed every day more or less."

PRODUCTION OF IRON AND STEEL IN CANADA DURING JUNE AND JULY 1921.

Pig Iron and Ferro-Alloys.

Abstract of Monthly Report of Dominion Bureau of Statistics.)

The total output of pig iron and ferro-alloys during July showed an increase of more than two thousand tons over the production reported by the Dominion Bureau of Statistics for June. Pig-iron output remained steady at slightly over fifty-four thousand tons; but the production of the several grades varied considerably from the amounts reported for the preceding month. Basic iron declined from 48,870 long tons in June to 40,720 tons in July, all of which was produced by the makers for their own use. Foundry iron which showed a total of 5,214 tons in June was used by the makers, and the balance, 1,204 tons was produced for sale. The ratio of foundry iron produced for use to the amount made for sale was, therefore, eight to one in July, while in the preceding month the ratio was one to five. There was a marked increase in the production of malleable iron during the month, the output rising from 661 tons made in June for sale to 2,922 tons made during Juy for the use of the producing firms. Electric-iron castings showed an advance over the previous month's record, the figures for the two months being 67 tons in June and 105 tons in July. Of the entire output of pig iron over 90 per cent was reported as having been made for the use of the companies producing.

The production of spiegeleisen was resumed in July and a total of 2,830 long tons was made for further use.

Other ferro-alloys, consisting entirely of the several grades of ferro-silicon amounted to 659 tons during the month, all of which was made in electric furnaces and produced for sale.

There were no changes during the month in the number of blast furnaces active, the six furnaces reported in blast at the end of June being kept in operation throughout the month. At th close of the month, therefore, six furnaces were active, namely, three at Sault Ste. Marie, one at Hamilton and two at Sydney.

Steel Ingots and Castings.

While the output of steel ingots and castings during the month of July was still almost 4000 tons in excess of the monthly average for the seven months of the current year, the actual output was about 10,000 tons lower that the quantity produced during the preceding month. The principal decline was in the production of steel ingots which dropped from 62,339 tons in June to 52,641 tons in July. Practically all the steel made during the month was basic open-hearth, 52,111 tons being produced by the makers for their own further use. In addition to this amount four tons of converter steel and 446 tons of electric steel was made and used. The total output of steel ingots made for sale amounted to only 160 tons during the month. The production of basic open-hearth steel-castings during July was nearly double that of the previous month, the actual output amounting to 630 tons as compared with 389 tons in the preceding month. The ratio of the production for use to the production for sale was maintained and the quantities produced were 185 tons of basic open-hearth steel-castings made for use and 445 tons for sale.

Electric steel production declined 1,278 tons in June to 608 tons in the current month. Of the latter amount 227 tons was produced for further use and 331 tons for sale.

Converter steel castings produced during the month, amounted to 99 tons, all but 10 tons of which was made for sale.

From the foregoing it will be seen that the output of direct steel castings of all kinds amounted to a total of 1337 tons during July, a decline of more than 400 tons from the 1764 tons produced in June. Of the 1337 tons reported, 865 tons made for sale and 472 tons was used by the producers. The average monthly production for the seven months ending July of the current year was 50,000 tons. Output for the past three months, it will be noted, has been in excess of the average monthly production for this year to date.

The average monthly production of pig-iron and steel in Canada is calculated annually since 1907 to have been as follows:

	(Long Tons)	
	Pig Iron	Steel Ingots & Castings.
1907	48,000	53,000
1908	47,000	44,000
1909	56,000	56,000
1910	60,000	61,000
1911	68,000	66,000
1912	75,000	71,000
1913	84,000	87,000
1914	58,000	62,000
1915	68,000	76,000
1916	87,000	106,000
1917	87,000	130,000
1918	89,000	140,000
1919	68,000	77,000
1920	81,000	92,000
1921 (7 months)	52,000	50,000

As forecasted in the last issue steel production during June and July showed some slight increase, and August figures should run about 55,000 tons or approximately half capacity of the plants at this time.

The closeness of the figures for pig-iron and steel production indicate very small movement of pig-iron across the border, and virtually all pig-iron produced is being used for manufacture of steel rails for the Canadian National Railways.

Analysis of Some Drill Steel Tests

By FRANCIS B. FOLEY,* Minneapolis, Minn.

With the possible exception of high-speed tool steel, the service demanded of rock-drill steel is probably more precarious than that of any other tool steel. Unaided by the helpful influence of alloys and dependent solely on the efficiency of the heat treatment applied for its ability to stand up under the abuse to which it is necessarily subjected, rock-drill steel is worthy of intensive study. For its heat treatment the smith has his fire, an oil fire perhaps, and a quenching bath; he judges the temperature by his eye. There are shops where excellent drills are produced by this method, but there are more where the product varies between very good and very bad. Pyrometers with specially designed equipment are used in but few cases.

But the responsibility for rock-drill failures does not rest entirely on the smith. Little has been published concerning the efficiency of drill steel, though the "Canadian Mining Journal"[1] published the breakage record of a large number of hollow drill steels. This record indicates that most of the breaks occur during the early life of the steel and that as a given batch of steel is used, its percentage of breakage decreases. This fact, the article points out, is at variance with the much-talked-of theory concerning failure from crystallization and fatigue. It seems to point to the fact that the greater part of drill-steel failure from breakage is traceable to faulty manufacture, resulting in defects in the bore of the hollow steel from inclusions of slag or oxides, etc. As this defective material meets with early failure, it is weeded out. In addition, some breakage may be caused by a lack of proper condition with respect to heat treatment of the steel as furnished by the manufacturer.

In the article mentioned, the breakage of $1\frac{1}{4}$-in. (3.17 cm.) hollow steel is given as 4.62 per cent. for the early period of use, with a decrease to 3.35 per cent. and 2.67 per cent. with time in use. For 1-in. (2.5 cm.) hexagonal hollow steel, the figures for the breakage are 0.18 per cent. and 0.06 per cent.; attention is called to the "enormous decrease in breakage by the use of smaller diameter drills." The figures are given as so many "drills sharpened," but there is no way of determining the percentage of tools broken, which must be considerably higher. For instance, from May 10 to August 9, or three months, there was a breakage of 2883 drills out of 85,882 drills sharpened, which means an average of 32 broken steels per day out of 954 steels sharpened per day. Of course, some of these broken steels are made into shorter drills and are not lost, so that it is impossible to determine, from the figures, what the true percentage of drills broken was. The figures are from records of a total of over 190,000 tools sharpened.

Breakage Caused by Faulty Practice in Forging and Hardening.

Breakage near the shank and bit ends of the steel is caused for the most part, by faulty practice in forging and hardening. The New Jersey Zinc Co., through the kindness of Mr. B. F. Tillson, has placed at the disposal of the Bureau of Mines records of drill-steel performance at Franklin, N. J. More than usual precaution was taken in the gathering of these data; those familar with the drill steel will realize the troubles incident to following tools in their many trips between the blacksmith and the miner. The tests were made with different lengths of steel, practically all of them not shanked, used in different kinds of drills and tested at different times. Undoubtedly, the length of the steel, the kind of drill, and the difference in conditions existing in the testing of steel day by day have some bearing on the question of drill-steel failures. However, no steel has been consistently favored or penalized with respect to these variables. It would of course, be ideal to have had all variables eliminated, except that of the brand of steel used, but these tests were not run for the purpose to which they have been put in this paper. Another desirable feature of this kind of testing is that all tools be tested to destruction, either until they had broken into unusable lengths or had worn too short. Records were kept of about 109 steels, representing seven brands, showing breakage, number of sharpenings, time of drilling, and footage drilled. Where breakage was recorded the pieces were measured and the position of the break thus located. All of the steels were of the same type of composition—carbon steels of 0.85 to 0.95 per cent. carbon.

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Reprinted from Transactions of A. I. M. M.E. for June 1921.

[1] Jan. 15, 1917.

TABLE 2

Brand	Number of Tools	Breakage: Within 10 in. of Ends			Breakage: Between Points 10 in. from Ends			Total Breaks	Total Drilling Time			Footage Drilled		Average Drilling Time per Break		Average Footage Drilled per Break		Average Inches per Minute
		Bit End	Shank End	Total	Bit End	Shank End	Total		Hours	Min.	Sec.	Feet	Inches	Min.	Sec.	Feet	Inches	
A	4	4	0	4	0	0	0	4	3	54	30	129	0	58	37.5	32	3.0	6.60
B	4	2	2	4	0	0	0	4	3	48	30	94	4	57	7.5	23	6.9	4.92
C	7	13	7	20	3	0	3	23	15	24	10	560	4	40	10.6	24	4.3	7.26
D	11	1	28	29	0	0	0	29	22	46	15	633	8	47	6.7	21	10.2	5.58
E......	24	3	50	53	3	16	19	72	26	10	35	636	0	21	48.8	8	10.0	4.86
F	6	1	24	25	0	1	1	26	14	22	3	454	0	33	9.3	17	5.5	6.30
G	39	48	45	93	2	0	2	95	83	39	5	2758	4	52	49.9	29	0.4	6.60
Total...............	95	72	156	228	8	17	25	253	170	5	8	5265	8	40	20.2	20	9.7	6.18
Per cent of total breaks			...	90	.	.	10											

As the ends of the tools are subjected to heat treatment and forging after leaving the manufacturer, only such breaks as occurred between points 10 in. from either end can safely be said to be caused by faulty manufacture. Such breaks are recorded in Table I. Brands C and E are evidently an inferior product and if they are left out, the total percentage of breakage is found to be but 4.7 per cent. This breakage was experienced in the testing of 3576 in. (90.8 m) of drill steel and represents, numerically, three breaks, or an average of a break for each 100 ft. of steel. It can hardly be claimed that a defect for each 100 ft. of hollow drill steel is extraordinarily high; on the contrary, it seems a remarkably good performance and indicative

TABLE 1.

Brand	Number of tools	Number of tools that broke	Per cent
A	[illegible]	0	0.0
B	[illegible]	0	0.0
C	[illegible]	[illegible]	[illegible]
D	11	0	0.0
E	[illegible]	14	[illegible]
F	6	1	16.7
G	39	2	5.1
Total	95	20	21.1

of a steel of very high quality, for it is unfair to attribute all the breakage to the defective steel. Granting, then, that considerable of this breakage is due to defective material, there remains a negligible number of failures to be attributed to other agencies, among which will appear so-called crystallization from fatigue. It is of interest to note that Brand G is in use at the mine from which the figures appearing anonymously in the "Canadian Mining Journal" were obtained.

Location of Breaks in Drill Steels.

The total breakage is given in Table 2. Here a division is made of breaks that occurred within 10 in. 25.4 cm.) of the bit end, within 10 in. of the shank end, between points 10 in. from either end but nearer the bit end, and between points 10 in. from either end but nearer the shank end. There was a total of 253 breaks, of which 173, or 68.4 per cent., were in the half of the steel with the shank and 80 in the half with the bit; 68 per cent. of the breakage in the middle section of the steel was nearer the shank end than the bit end. That breakage is more prevalent in the half of the steel nearer the drill is to expected when it is considered that, while the bit end is left free to yield, under the bending and vibratory stresses applied, the shank end is held fairly rigid in the drill. Table 2 shows that about 90 per cent. of the total breakage occurred within 10 in. (25.4 cm.) of the ends of the steel; in other words, in the portion of the steel heated for forging. Some of this breakage may be said to be caused by fatigue, but the existence of such a phenomenon in steel is doubtful and is denied by many investigators.

In order to get a better idea of the location of breaks at the ends of the steel, the curve shown in Fig. 1 has been plotted. This curve has been derived by plotting at the even inch, breaks that occurred within ½ in. (1.27 cm.) of that point. The position of maximum breakage in the tools shown by the sketches of the shank and bit ends. The different steps taken in forging and hardening the steel are given in order that the full value of this curve may be appreciated. The shank end is considered first. When a collar is necessary, which was not the case in the tests under discussion, the fresh steel is heated for about 6 or 7 in.)15.2 or 17.8 cm) from the end and the collar is forged by upsetting. The condition of the metal at the farthest point of heating undergoes a rather sharp change from the annealed structure of the original material to a structure produced by the cooling from the forging temperature. The shank is then reheated for a distance, which probably varies up to 7 in. from the end. to a temperature above its critical range, but probably below the temperature for forging, and is plunged in oil. There is, then, a change from the annealed to the oil-quenched condition. When a lug or collar is forged there may, therefore, be a number of structurally different zones, depending on the length of the steel heated for hardening; namely, the original structure of the bar, that produced in the cooling of a part of the bar heated for the upsetting operation but not worked, that produced in the upsetting, and finally the oil-hardened structure of the end. When it is realized that, while the shank end of the steel is supported in the chuck of the drill, the shaft of the steel outside the drill is subjected to considerable vibratory and bending stresses, the stresses that this heterogeneous region is expected to withstand will be appreciated. It is no wonder that most of the failures from breakage are found in this region.

Much the same kind of operation is undergone by the bit end of the steel. About 4 in. (10 cm.) of it is heated for forging, and afterwards only ½ to 1 in. (1.27 to 2.5 cm.) is heated for quenching in water. Here, again, there are probably three zones of structurally different material, and the breakage is maximum at about 3 in. (7.6 cm.) from the tip of the bit.

The condition just outlined point to the necessity of closely controlling all the conditions for heating and cooling. This is borne out by the record or sharpenings in Table 3, which includes the sharpenings necessitated by breakage, because the records did not differentiate with respect to sharpenings necessitated by dullness and those made necessary as a result of breakage, the number of sharpenings having been kept and not the duration of the run for each. The small number of breaks encountered in brands A and B accounts,

TABLE 3

Brand	Number of Tools Tested	Number of Sharpenings	Total Drilling Time			Footage Drilled		Average Drilling Time per Sharpening		Average Footage per Sharpening		Average Inches per Minute
			Hours	Min.	Sec.	Feet	Inches	Min.	Sec.	Feet	Inches	
A	8	12	23	6	00	720	1	115	30 0	60	2 5	6 24
B	8	15	20	37	30	560	1	82	30.0	37	4 1	5.43
C....................	5	33	11	17	00	447	2	20	30 9	13	6 6	7.92
D	11	78	31	11	45	822	11	23	59.8	10	6.6	5 27
E	24	162	26	12	41	645	1	9	42.5	3	11.8	4.92
F	6	56	14	22	3	454	0	15	23 6	8	1.3	6 30
G	47	286	119	6	5	3782	4	24	59.2	13	2.7	6.32
Total....	109	642	245	53	4	7431	8	22	59.0	11	6 9	6 04

in a measure, for the great drilling time per sharpening. The total average drilling time per sharpening is practically 23 min. for an average footage of about 11½ ft. (3.5 m.), yet the maximum drilling time per sharpening for any tool was 6 hr. 43 min. and 30 sec. for a footage of about 245 ft. 9½ in. (61 m.). There is, therefore, room for considerable improvement of the average.

Conclusions.

To summarize, drill steel should be in the best condition when received from the manufacturer, free from imperfections of a mechanical nature and from impurities; it should also be in the best annealed condition to withstand the vibration and shock its service will entail.

There is, for a given steel, a temperature and a rate of cooling from this temperature that will produce the conditions that will best withstand the stresses of shock and bending.

Lack of uniformity in performance shows a lack of uniformity in the heat-treating operations, which may be overcome by the devising of means, of an automatic or "fool-proof" nature, that will attain the desired result without calling for excessive skill on the part of the smith.

Experimentation with the heat treatment of the shank and bit ends of the steel might lead to alterations in the present method of heat treatment that would do away with or mitigate the evil effects of the sharply defined zones of structurally different material, which must result to a more or less extent from present practice.

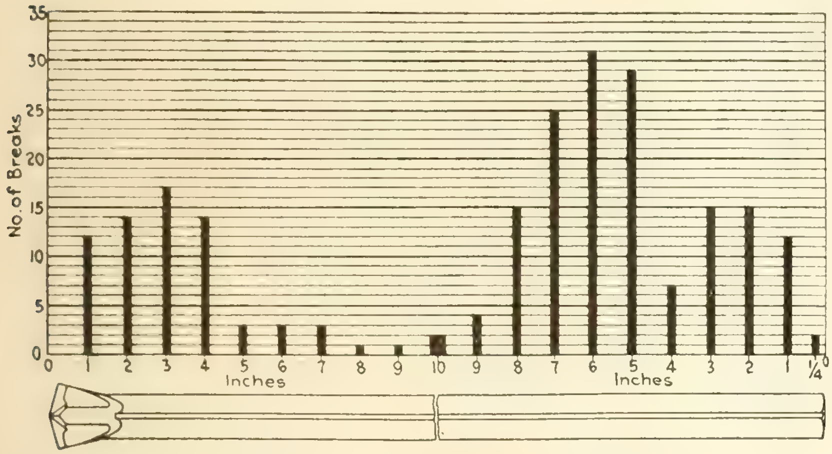

Fig. 1.—Curve showing breaks that occurred within ½ in. of the even inch. Also sketch of shank and bit ends.

WINNIPEG RAILWAY TO HAVE BIG POWER PLANT.

It is reported from Winnipeg that arrangements have been concluded for the financing of a $10,000,000 power developing project at Great Falls on the Winnipeg River, A. W. McLimont, Vice-President of the Winnipeg Electric Railway Company, has announced. Mr. McLimont recently has returned from a trip East, where he consulted with officials of financial corporations.

When completed, the plant to be developed will have a capacity of 168,000 horse power. Work on the project has been begun, and about 200 men now are employed. Later from 1,000 to 2,500 men will be employed on the construction of the plant, which will be one of the world's largest systems for the development of electrical power. It will be completed in 1927, it is announced.

The undertaking will be carried out under the charter of the Manitoba Power Company, Ltd., which company is taking over the plant and assets of the Winnipeg River Power Company, Ltd. In the Manitoba Power Company, Ltd., Sir Augustus Nanton, as President will be surrounded by a strong directorate, A. W. McLimont will be Vice-President, and the active management of construction and operation will be in his hands.

Nesbitt, Thompson & Co., Ltd., investment bankers, of Montreal, who will have associated with them several eastern banking houses, will finance the development. A. J. Nesbitt, who is head of the above firm, is also a director of the Winnipeg Electric Railway Company.

ELIMINATING BLOW HOLES IN THERMIT WELDS BY THE USE OF NEW MOLDING MATERIAL AND NEW STYLE MOLD BOXES.

A new grade of molding material for Thermit welding has recently been developed by the Metal & Thermit Corporation, New York, for repairing roll necks, pinions, crank shafts, locomotive frames and other heavy steel sections for steel plants, which, as proved by extensive researches and practical experiments, when used in accordance with the regular Thermit practice, will definitely prevent blow holes and assure sound welds. This new molding material has already been introduced in many of the larger railroad shops, where the beneficial results obtained therefrom have won enthusiastic approval. The new material, designated as "Thermit Molding Material" is quite different from ordinary molding material and in all Thermit work, either this, or a substitute which has been tested and approved by the Metal & Thermit Corporation should invariably be used. In view of the great importance of using this new molding material, it is now beng sold practically at cost.

The design of the new molding material is based on the theory that good silica sand will stand the heat of the Thermit reaction very well and that the weakness in all molding material is the clay binder. Therefore, there should be as little clay as possible in the mixture, in order to make the mold more refractory and to increase its porosity. It is logical therefore, that the use of a plastic clay be selected instead of a fire clay, as formerly. The sand and plastic clay are ground together in foundry pan or moller, with the intention of coating each grain of sand with a minimum thickness of clay. This has resulted in a good, clean molding material, which should be rammed hard in the mold, which will stand up well under the preheating flame and which is extremely porous to the gases generated in the mold resulting in a sound weld with a very clean exterior. Although suitable molding material can be made by increasing the clay content slightly and mixing the clay and sand thoroughly by hand, it is not so good as that made with a smaller clay content in the foundry pan or or moller.

The mixture now being used is composed of the following: 3 parts clean, sharp silica sand, (100 percent of which should pass through a screen having a .03 in. square opening, and 40 percent of which should be retained on a screen having a .012 in. square opening) mixed with 1 part Welsh Mountain plastic clay. These parts are first thoroughly mixed in the moller together with 1/40th part glutrin by volume and sufficient water (1/12th part) to bring to the proper consistency. If mixed by hand, the sand and clay must be dried before mixing (being careful not to subject the clay to a temperature higher than 400° F.) and thoroughly mixed before adding the glutrin and water. The glutrin should be mixed with the water before adding to the sand and clay.

In case a plastic clay fatter than the Welsh Mountain be used, the mixing, of course, will have to be more thorough and less clay used. Welsh Mountain clay is being used in the present mixture because in carefully run tests it has proved to be the most refractory. The use of the new molding material necessitates harder packing next to the weld; in fact, the regular Thermit rammer may be supplemented by the use, for instance, of a tool having an end ⅜" x 1½", so that the operator may be able to peen the sand next to the wax collar and the various patterns.

It is absolutely essential, in the production of sound welds, to be sure that no loose sand exists in the mold when the Thermit steel is poured. This is why very hard ramming is advocated, also why it is most important to blow out all loose material from the interior of the mold by putting the preheating burner in the riser before the heating gate is plugged and being sure that no sand is detached by the operation of inserting this heating gate. The burner should be removed from the riser before plugging the heating gate, because otherwise it may detach some sand, which could not be blown out after the plug is in place. The heating gate plug should be thoroughly dry; and, if it has been carried in stock for some time, it should be warmed before using.

By perforating the sides and bottom of the mold box, the escape of the gases which pass through the molding material is greatly facilitated. ⅜" dia. holes, spaced 3 or 4 in. apart, are sufficient. To facilitate the escape of gas from the bottom of the mold box, the mold should rest on blocks, not directly upon the foundry floor. As unnecessary molding material simply increases the resistance to the passage of gas, the mold box should be made as small as possible commensurate with safety. For example, in welding a 4 in. x 4 in. section, only about 4 in. of sand is necessary at all points, except, perhaps, on the pouring gate side. It is most important to thoroughly vent the mold box by forcing a rod or wire down at a number of points to within ½" or so of the collar. Care should be taken that these do not touch the collar because such vent holes will fill with steel and will therefore not facilitate the escape of gas.

CAN. BRILL COMPANY TAKES OVER PRESTON CAR.

Shareholders of the Preston Can & Coach Co., Preston, Ont., have approved arrangements whereby the Canadian Brill Company, Ltd., will take over and operate its plant. The new company is starting operations immediately and has behind it the entire financial, engineering and manufacturing resources of the J. G. Brill Company of Philadelphia, of which the new company is a subsidiary.

The new company start operations with a substantial volume of business, having orders on hand from Toronto and Winnipeg and the Timiskaming & Northern Ontario Railway, which will serve to solve the unemployment problem in Preston. The reorganization of the Preston Car & Coach Company will mean the bringing of considerable American money to Canada at once, and an increasing amount before long. All the work will be done in Canada, and it will mean an increase in the purchasing in this country, orders already having been placed with some Toronto firms.

The J. G. Brill Cmpany of Philadelphia, the owners of the new company, is the largest company in the electric street railway car business in the world, and it also manufactures automobile bus bodies. The parent plant is operated in Philadelphia and there are other big plants at St. Louis, Springfield and Cleveland, and one in Paris, France.

The President of the new company is Samuel M. Curwen of Philadelphia, President of the Brill Company and all subsidiaries; First Vice-President, H. K. Hauck, General Manager of the G. C. Kuhlam Car Company of Cleveland; Second Vice-President, A. N. W. Clare of Preston. H. D. Scully is a director and General Manager. Another Canadian director is yet to be appointed, as well as two more American directors.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

THE REMOVAL OF DUST IN ROCK BORING.

Glückauf, the German mining periodical published at Essen a. Ruhr, Westphalia, contains in its issue of 23rd July an article by Bergassessor Wedding on the disposal of dust from the process of rock-boring underground. The ill effects of exposure to dust depends on the kind and quantity of the dust, the length of the exposure, the age of the workmen so exposed, and the nature and severity of the manual labour; which in its turn depends on the location of the working place and the arrangement of the drilling apparatus in use. Fine dust is more harmful than coarse dust, as it penetrates further into the bronchial tract. On the other hand, fine dust is more easily ejected and its tearing action on the body tissues is less. Sharp particles are of course more dangerous than rounded ones, and siliceous rocks are especially apt to give off harmful dust. The length of exposure to dust greatly increases the harmful effect, because the mucus membrane of the breathing tract loses its moisture through caking of the dust. Fine hair-like processes which cover the mucus membrane are in normal health in constant movement in the direction of the outer atmosphere for the purpose of ejecting dust, but they cease to function if covered with a dust layer, and damage is done to the whole breathing tract, setting up inflammation, swellings and lesions in the mucus membrane, and allowing dust to enter the lung tissues. Strong youthful individuals can withstand the harmful effects of breathing dust better than older and weaker individuals, but they suffer to a certain extent, especially if the type of boring machine used necessitates a more or less bent position, and the work induces rapid and deep respiration.

The nature of the working place plays an important part in the dust danger, as some spots are better ventilated than others. A strong air-current may be disadvantageous, because in restricted passages of the mine, the air-current may whirl about the dust as it falls out of the bore-hole. Of especial importance is the dampness of the strata and the mine atmosphere. The dust is naturally less dangerous under damp conditions.

The hammer-drill, with its succession of swiftly repeated blows, naturally sets up more dust and creates sharper particles than the rock-drill with a slower stroke, or the rotating drill; and, as the hammer-drill is held in the hands, the contact of the worker with the dust as it is ejected from the bore-hole is closer.

There are therefore many factors to be considered, which act in a varying manner to decrease and to increase the intensity of the dust-cloud. Long-continued drilling in dry hard sandstone with the hammer-drill is especially harmful, whereas boring in damp strata and soft shales with rotating-type drills under conditions of good ventilation is entirely without possibility of ill-effects.

Many devices have been tried to diminish the dust danger. The passing of water into the drill-hole entirely settles the dust, but it creates a condition that is onerous for the worker and is technically very difficult to arrange, because at every change of the drill the water-connection must be made anew, and a tight connection is difficult to maintain because of the vibration of the machine. Also the slime from the borehole is so disagreeable, especially in overhead holes, that the driller will prefer the dust to the spilling of water and mud all around and over his person.

The use of masks usually results in their rejection by the wearer because of their interference with his breathing and their general uncomfortableness.

The latest device is designed to remove the dust from the hole , immediately it is created, by means of suction set up by compressed air, and to lead it through a pipe to some place where it can be deposited without danger to the workers.

The Ministry of Trade & Commerce for the Mine District of Dortmund in cojunction with the Mine operators Association has carried out a series of trials extending over three months with devices of this nature. They consist essentially of a hood fitting over the apperture of the bore-hole, in which a sufficient suction is set up to remove the dust, and to transport it along a flexible pipe to the point chosen for deposition. A number of such devices have been designed and put on the market by Westphalian manufacturers of mine equipment, which, while differing in detail of application, are constructed with the same idea of removing the dust danger by removing the dust from the bore hole and the vicinity of the worker to a point where it can do no harm.

The devices are said to have been successful in removing dust, but it is admitted that they entail a certain hindrance to drilling and some loss of time in changing the hood. Also in some cases, where the boreholes are placed in positions difficult of access, some difficulty has been experienced in making room for the attachment of the hood and dust pipe. A thoroughly satisfactory solution of all the problems connected with the application of this device has not been found, and when the visit of an official has not been expected the workers have failed to attach the device.

Experiments have been made with hammer drills with a backward exhaust, instead of the usual exhaust towards the bottom of the hole, and further information regarding this development is promised.—F. W. G.

REFRACTORY SILICA BRICK IN UNITED STATES IN 1920.

The refractory silica brick industry in the United States continued to make progress in 1920. These brick are used principally in by-product coke ovens, in open-hearth steel furnaces, in copper reverberatory furnaces, and in the glass industry, in which they must withstand high temperature, such as would fuse ordinary clay fire brick. They also withstand abrasion well. The output in 1920, as estimated by Jefferson Middleton, of the United States Geological Survey, Department of the Interior, was 255,000,000 brick, valued at $15,540,000, or $60.94 a thousand, an increase of 18 per cent in quantity and 32 per cent in value as compared with 1919. The quantity marketed in 1920 was exceeded by that in 1917 and in 1918, when the stress of war caused an increase in the production of all refractories. The value in 1920 was exceeded only by that in 1918. The price per thousand in 1920 was the highest recorded. The output in 1920 was 46 per cent greater, the value 307 per cent greater, and the average price per thousand 178 per cent greater than in 1913.

After being shut down for a few weeks the Canada forge plant of the Canada Foundries & Forgings Limited, has been reopened to take care of heavy forging requirements for the shipbuilding and ship repairing industry.

IRON & STEEL

OF CANADA

PUBLISHED MONTHLY

Devoted to the Iron, Steel, Foundry, Machinery and Metal-Working Trades, the Allied Coke and Coal Distillation Industry; to Steel Shipbuilding; and to the Mining and Utilization of Coal, Ferrous Ores, Fluxes and Refractories, all with Reference to Canada.

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EDITORIAL

REMEDY FOR UNEMPLOYMENT IN STEEL INDUSTRY.

Commenting on unemploym nt in the Steel industry in the United States, "Iron Age" points out that immediate improvement would come if transportation charges, fuel cost and building trades labor cost were reduced to pre-war time levels. Transportation charges are nearly double, fuel costs more than double and building trades labor costs double that before the war.

In ordinary periods of depression there is usually an opportunity to build up stocks at low cost. With costs still abnormally high, it is folly to manufacture material for which there is no immediate demand. In the steel industry, as in many other industries, there is now no market for high cost goods.

In Canada, there is also much criticism of high transportation charges but little chance of large reductions owing to the difficult position in which the Government railways find themselves. Fuel costs will come down here when they come down in the United States. Building trades labor costs are so seriously hampering construction, and are so generally considered unreasonable, that they are likely to come down in the near future.

There can be little doubt that the unreasonable demands of building trades labor is keeping a lot of men in other industries out of employment. It can hardly be expected that a proper adjustment of the rate of wages paid to this one group would, of itself, right conditions, but there is evidence that it would be a big step forward in the solution of the unemployment problem.

THE STEEL INDUSTRY IN CANADA.

It is gratifying to learn that the production of steel ingots and castings in Canada for the month of August last, totalling 72,023 tons, was the highest month's output since November of last year. According to the Dominion Bureau of Statistics, there was an increase of [illegible] per cent., or 17,698 tons, of steel ingots over the previous month's output. Basic open hearth steel accounted for the increase, August's total being [illegible] tons, as compared with 52,111 tons in July. The production of direct steel castings during August amounted to [illegible] tons which represented an increase of 347 tons over July's total.

As we have said, this increase in production is gratifying. It is especially so at this moment when, in the position in which the steel industry has found itself for nearly a year now in this country, any indication of a turn in the tide, in the direction of increased activity, is doubly welcome. The steel industry in Canada has come into existence practically within the last twenty years or so. And, during the war, a combination of circumstances enabled it to attain to a position which, under the most favorable auspices, must necessarily be subject to considerable modification in the long years of peace, on which, presumably, we have entered. It may be that, in time of peace, it will be beyond the competency of this country to retain, or, rather, to regain, the position that it held as an exporter of steel, as of iron, goods in war-time. For this is a matter in regard to which the cost of coal production in Canada, as compared with the cost of coal production in Europe, must eventually prove a decisive factor.

The question of export trade is one which has a very vital bearing on the future possibilities of the industry in those regions which about on either the Atlantic or the Pacific Oceans. It is those regions which must, in the nature of things, be most adapted, if any part of Canada is so adapted, to the development of an export trade in steel goods.

In the central Provinces of Canada, the steel pla are quite frankly, as we have more than once pointed out in these columns, an extension of the industrial stimulus of the great central coal field of the United States. Thus the steel industry in this country does not wholly justify itself on the ground that Canada possesses the requisite natural resources. Nevertheless, so far as the steel plants in the central Provinces are concerned, its existence, as an integral part of the industrial life of this growingly-important industrial nation, is justified, to an immense extent, by the contiguity of those plants to large fields of coking coal and large deposits of iron ores, to their facility of access to great waterways, and, generally, to favorable geographical considerations.

It is somewhat difficult to express the position of the steel industry in the central Provinces with minute discrimination. But the point we are seeking to make is that it cannot be fairly charged against it that it is the creature and the creation of fiscal arrangements of an artificial kind. At the same time, it cannot be denied that, but for a protective tariff, it would have been quite out of the question for it to have attained

to its large proportions. That such a protective tariff, as against steel imports from other countries, is in harmony with general Canadian sentiment, we entertain no doubt whatever. For the existence of a steel industry of our own has fostered the feeling of national consciousness and independence which is so marked a feature of the present-day Canadian character. Indeed, it may be a question whether the tariff protection that has been afforded the steel industry has not erred somewhat on the side of inadequacy. But, assuming that such is the case, it can at least be argued in favor of the policy adopted, that it has not from that very fact, done anything to derogate from the general Canadian sentiment in favor of a steel industry of our own.

We have no doubt that that sentiment will grow with the growth of the nation. The present condition of the ship-building industry is nothing to glory in. It is quite likely that, in this direction, too much all at once was attempted, and attempted too soon. But no thinking man who has regard to the requirements of our commerce of the future, to say nothing of considerations of national defence, can doubt that that industry is destined—and it may be sooner rather than later—to loom large among the staple industries of the country. The steel industry, as a whole, is now one of the bulwarks of Canadian trade. It is has become an essential part of our national economy, and is an essential concomitant of our national policy—using that expression in no narrow party sense—on its accepted and permanent basis.

THE BELCHER ISLANDS.

Reports of iron ore discoveries at Belcher Islands have been not taken very seriously by many people, but a few interested parties are strong in their belief that the makings of an iron ore mining industry exists in these islands in Hudson Bay. In this issue on another page will be found some excerpts from an article by an American iron mining engineer who examined the deposits last summer. His remarks indicate that enough is now known to warrant considerable expenditure in diamond drilling and other exploratory work, to determine whether the deposits are good enough to warrant the heavy expenditures necessary to develop and operate producing mines.

The Dominion Government has evidently been somewhat impressed with the possibilities of establishing an iron mining industry in the Far North, for there is now a geological survey party making an examination of the Islands for the Government, Dr. G. A. Young is in charge of the party and his report should be of interest.

Mr. Woodbridge is not unmindful of the difficulties of transportation and of the inhospitable climate and it is therefore doubly interesting to note that he is confident that the obvious difficulties will be successfully overcome if development is reasonably satisfactory.

TURNING TITANIUM TO ACCOUNT.

The utilization of Canadian iron ores is a problem that has attracted much attention and which needs a lot more study than it is getting. Our iron ore deposits have not yet contributed any large part of the ore smelted in Canada. The large scale operations in the Lake Superior states, where there are large bodies of iron ore of good grade, have made possible the production of ore at prices which discourage those who might undertake the development of our own deposits. We have large quantities of iron ore which will doubtless some day be mined, and the indications are that the day is not very far distant when competition will be possible. Already concentration of ore has begun on a large scale in Minnesota. Lower grade ores are appreciating in value and iron ore mining on a larger scale is looming up as a possibility of the future. There is little to indicate, however, that Canada will produce as much iron ore as it uses for some years yet.

The utilization in a reasonable time of such iron ore deposits as are known in Canada will only be possible if the nature of the deposits is thoroughly investigated, and methods of treatment devised that are best suited for the ore. To use our ores economically, we must find out their peculiarities and turn them to account. Intelligent research often results in the transference of items from the unfavorable to the favorable side of the account.

In this connection, the investigation of titanium bearing iron ores described on another page is of interest. By turning the presence of titanium to good account, and making a slag in such a way that this element acts as a base in a high acid mixture, instead of an acid in the ordinary mixture, the investigators show that high silica and titania in iron ores may prove to be a source of profit rather than of loss. By using silica instead of lime as the fluxing agent, titania acts as a base and serves in the slag the function served by lime in the ordinary slag. This investigation should give new impetus to the study of the commercial possibilities of our titaniferous iron ores.

Such investigations have an importance greater than the solution of the particular problem attacked. They give an incentive to others who would carry on investigations on the general problem of making use of such resources as we have, instead of too easily concluding that the resources are not of value because not suited to the processes in use, which processes have been devised to meet the peculiarities of ores of a different type.

THE FORD FOUNDRY.

The new Ford foundry plant at River Rouge will have a daily capacity of about 2,500 tons of castings. The mechanical equipment is exceptionally complete. The making of castings directly from the furnace will be practiced on a large scale.

EDITORIAL NOTES.

During the past few years the use of hollow drill steel has greatly increased in the mining industry. At At many mines the solid drill steel has been to a large extent replaced by hollow, which permits water being fed to the bit through the steel. As drill steel is consumed in large quantities the article in this issue on the method of manufacture of hollow drill steel from hollow ingots is of interest.

The scarcity and high price of silica brick during the war led to investigation of the possibilities of making silica brick in Nova Scotia for the iron industry there. Some account of the experimental work carried on was given by A. W. McMaster, of Sydney, at the Cape Breton branch of the Engineering Institute. It is an interesting account of an industry developed during war-time pressure.

The extension of the Ontario Government railway to a point seventy miles north of Cochrane, the present northern terminus, is to be undertaken soon. Another eighty miles will bring the steel to James Bay and open up new possibilities for development of iron ore deposits on the Belcher Islands and should give an impetus to further exploration of the Hudson Bay region.

Canada was the leading buyer of steel from the United States in August. Imports in that month included 6,084 tons plates, 2,230 tons sheets, 2,574 tons bars, 4,094 tons structural steel, and 2,412 tons billets. Steel exports of the United States during August were the lowest in twelve years.

The manufacture of shells in Canada during the war resulted in the devising of many new methods. Some accounts of variations from English methods introduced by Canadian manufacturers was given in a paper presented at the Paris meeting of the Iron and Steel Institute by Capt. H. W. Swabey and R. Genders. A summary of this paper will be found on another page.

One result of the war will be the doubling of the iron ore production of France. The output of the Lorraine area recovered by France was in 1913 about equal to that of France. It will be some time, however, before the output of the French Lorraine area will be at the pre-war rate owing to the destruction wrought by the Germans.

Mr. Ernest S. Jefferies of the Steel Company of Canada presided at the meeting of the Association of Iron and Steel Electrical Engineers at Hotel La Salle, Chicago, Sept. 19-24. About 400 attended this, the 15th annual convention of the Association. Mr. Jefferies retires as president this year and will be succeeded by Mr. W. P. Hall of the Illinois Steel Co., Chicago.

STAINLESS IRON.

For some years past stainless steel has been used freely in cutlery, and the saving it effects in labour seems to be securing it increasing popularity in spite of some apparent uncertainty in quality. This uncertainty is probably due to the use of a picturesque name by a number of firms indifferently, and is a reminder that the public as well as the manufacturer has an interest in requiring that a brand shall denote the product of a single works, and not of one works out of several. Stainless steel, however, was not developed for the purposes of the dining table or scullery, but for the very different use of resisting the erosive effect of heat gases in ordnance, and although not much has been heard of it in general practice, sufficient experience has been gained of its service in ordinary engineering duty to make a rough stocktaking of its position and prospects worth while.

Mechanical Properties.

The latest development of stainless steel is what is called "stainless iron," which in composition is substantially the same product except for the amount of carbon that it contains. For practical purposes stainless steel may be taken to be a ferro-chromium alloy, usually with something under 1 percent. of nickel and carbon running up to something over 0.5 per cent. The "steel" part of the name is derived from the fact that these steels can be forged, hardened and tempered, and on this ground the term is restricted to materials containing from 11 to 14 per cent. of chromium. Here, however, the nice discrimination that led Mr. Harry Brearley, by whom this important group of materials has been and is being worked out, to select the generic title of steel appear rather to have gone back on him, because the "steel" that contains less than 0.1 per cent. of carbon has now been called stainless iron, although unlike any known form of iron it retains the ability to be forged, hardened and tempered that distinguished the materials with higher carbons.

The introduction of the low-carbon material, whether it be called iron or steel, marks an important advance in the application of stainless steels. It has been delayed owing to the difficulty of procuring practically carbon-free ferro-chromium. Ordinary ferro-chromium contains anything from 5 to 9 per cent. of carbon, and up to now it costs many times as much to get rid of the carbon as to procure the original alloy.

There are, however, a number of uses for which stainless steel is well worth what it costs, and adds a great deal more than the excess cost in the way of quality and resistance to wear. The advantage of the low carbon is that the material is far more readily forgeable than are the varieties hitherto available. It is said in fact to forge about as easily as a 0.45 per cent. carbon steel, and to allow four to six times as much work to be done on it at one heat as can be done on ordinary stainless steel, the harder varieties of which are almost as difficult to forge as high-speed steel. To some extent the resistance of either stainless iron or steel to corrosion will vary with the temperature to which it has been subjected, but it will always be considerably more resistant than ordinary steels, however treated.

Mr. Charles M. Schwab of the Bethlehem Steel Corporation and Mr. James A. Campbell of the Youngstown Steel & Tube Co. represent the Steel Industry on the committee appointed at the employment conference at Washington.

Iron and Steel Institute of Britain

Autumn Meeting Held in Paris.

At the Autumn Meeting of the Iron and Steel Institute of Britain held on September 5 and 6 in Paris, a number of very interesting papers were read dealing with a variety of subjects connected with iron and steel production.

Manufacture of Shells in Canada.

Captain H. W. B. Swabey, C.M., M.E.I.C., and R. Genders, M.B.E., B.Met., A.I.C., described the manufacture of shells in Canada during the War, and showed the interesting variations which were introduced by Canadian manufacturers from existing English shell practice, in connection with the casting of small ingots to combine large production with accepted sound methods of casting.

Sixty-five per cent. of the production of shell steel in Canada was by means of the basic open-hearth process. the acid open-hearth process accounted for 25.8 per cent., and the basic electric for 7.8 per cent. The first mentioned type was practically all cast in 3 ton ingots. These were either rolled into blooms and later reheated for rolling into bar, or rolled into bar direct. The former method was the best. Basic steel provided all the material for the 18-pdr. H.E. shell and shrapnel shell.

The 18-pdr. H.E. shells were made by boring from the solid billet cut from the rolled bar. The final mechanical tests of the steel were taken at the rolling mill, and the acquirement of the necessary properties was thus dependent to a large extent on the treatment received in the rolling and during the subsequent cooling.

If the manufacturer desired the bars might be normalised or annealed. but little steel was so treated. Manufacturers experienced difficulty in finishing rolling in such a way that the steel gave both the yield point and the elongation required. At a later date conditions were somewhat eased by the specified elongation being reduced from 17 to 14 per cent when the maximum stress was not less than 40 tons per square inch.

All shells other than the 18-pdr. H.E. were machined from hollow forgings made by punching, followed in some instances by a drawing operation. The billets generally in the form of small ingots were made lightly smaller in diameter than the final forging in order to fit easily into the die of the press.

At the commencement of H.E. shell steel manufacture a number of foundries cast the small ingots for 4.5, 60 pdr., and 6-inch shells of sufficient lengths to make two billets after the removal of a 20 per cent discard.

The length of such ingots was large in proportion to the cross sectional area, and a large precentage of ingots showed secondary piping. This type was therefore replaced by a shorter ingot from which only one shell could be made. The 8-inch and 9.2 inch shells were forged with a solid nose and open base so that tapered ingots could be cast wide end up and sound steel produced.

For shells forged with solid base a tapered ingot was thought to be impracticable, but one maker adopted a design of ingot cylindrical for about 4 inches from the top and then tapered to an almost square base, the diagonal of the square being equal to the diameter of the cylindrical portion. No trouble was experienced with secondary piping or during forging. Subsequently a unformly tapered ingot was generally adopted for 6-inch shells although it necessitated making a slightly heavier forgings to give sufficient margin for the removal of the radius left at the corner of the base. At some plants rejections decreased to less than 1 per cent ofter the adoption of tapered ingots for 6-inch shells.

The 8 inch and 9.2 inch shell forgings required a mould with a solid bottom, but for other shell types open moulds were employed. Both brick and sand heads were used. In the general design the head was slightly less in internal diameter than the ingot and might be provided with a lip which closely fitted the top of the mould. Both cast iron and steel stools were used with open bottom moulds, and a layer of thick paper was generally laid on the stool before casting to prevent burning. The use of mould washes was not favoured.

The casting of large ingots for rolling was done by means of a bottom stoppered label having a nozzle 1 to 1¾ inch diameter. Ingots were top poured and brick sinking heads were sometimes used. The tapered ingot was not adopted in Canada in casting large ingots for rolling, and deoxidising by means of aluminium was discouraged. The forging presses used varied from 200 to 1,000 tons and the billets were heated in continuous or oven furnaces, fired in the majority of cases by oil, but sometimes by coal. The paper from which the above notes are taken included details of the cooling processes used and the inspection and testing methods by means of which the chemical analysis and physical properties of the ingots and bars were maintained at the required standard.

Destruction of Metallurgical Plants by Germans.

L. Guillet, of Paris, dealt with the systematic destruction of the metallurgical industries of north-eastern France by the Germans, and the progress towards their rehabilitation which has so far been made. The coal output of France in 1913 was 40,000,00 tons, half from the occupied area, and iron ore output nearly 22,000,000 tons, 83 p.c. from the invaded area. Over 60 p.c. of the pig iron producing work and of the steel works were in German hands.

M. Guillet showed that only a small part of the destruction of these works was due to the war, the major part being through deliberate breaking up and blowing up of the works, and carrying away of the valuables by the enemy. He demonstrated, however, that the reconstructional energy shown by the industry had been admirable, and that in spite of financial and other difficulties the works were gradually resuming their activities, and that reconstruction has been carried out on modern lines so that the future prosperity of the industry may be predicted.

Iron Ore Deposits of France.

One of the most instructive papers read before the Iron and Steel Institute was the one by P. Nicou, of Paris, on the Iron ore deposits of eastern and western France. France has now become the largest iron ore producing country in Europe, and as Britain is forced

to purchase a large quantity of the ore for her blast furnaces from external sources, the interest taken in French iron ore on both sides of the Channel is naturally very great.

Seven years ago the autumn meeting of the Iron and Steel Institute was to be held in France, and the great French iron ore mines and iron and steel works were to be visited. What happened to those works and mines instead is indicated above. But when the reconstruction of the area has once been completed the iron ore producing capacity of France will probably be doubled. At any rate this is so on the basis of the 1913 figures quoted by M. Nicou, for the total iron ore output of France in that year was 21,917,870 tons, and of German Lorraine 21,136,265 tons, which area has now been recovered by France.

Owing to the systematic destruction of the iron ore fields, the output of the French mines has temporarily fallen very greatly. When conditions become normal again Britain will be able to secure her ores from Normandy, Anjou and Britany as in the past, but transport charges from Lorraine are still prohibitive, and likely to remain so for some time, as the various water transport schemes contemplated will take a long time to carry out. M. Guillet dealt fully in his paper with the economic and geological features of the various iron ore fields in France.

Critical Point and Strength of Magnetising Field.

Amongst various metallurgical papers, was one read by Mr. Kotaro Honda, of Japan, on the question whether the critical point depends on the strength of the magnetising field. It is generally accepted that the critical point or A2 transformation point is not affected by the strength of the magnetising field. By the critical or A2 point is meant a temperature at which ferro-magnetism vanishes, or at which the subtance changes from the ferro-magnetic to the paramagnetic, but not the point at which the change of magnetisation, or the evolution or absorption of heat, is a maximum, as usually taken by metallurgists. Numerous experiments previously made for the determination was not sufficiently accurate. The strength of field was usually varied up to several hundred C.G.S. units, and within this range, and according to the accuracy attained, the critical point was practically found to be independent of the strength of field.

For an accurate determination of the critical point in different magnetising field it is necessary to use an apparatus of higher sensibility, such as a torsion-balance.

Mr. Honda described a number of experiments carried out in this connection from which he concluded that the critical point is not affected by the magnetising field The magnetic or A2 transformation is very probably a progressive change going on in the molecules themselves with the rise of temperature, and the change of magnetisation is only one aspect of this internal transformation as revealed magnetically. The critical point of such an internal change will not easily be affected by an external factor, such as a magnetic field.

Heat Treatment of Steels.

In discussing the characteristic curves of the heat treatment of steels, Messrs. Albert M Portevin and Pierre Chevenard pointed out that recent researches on the hardening of steel have led to the stablishment with, in this instance, great accuracy, of the mutual relationship which exists between the two fundamental factors of all heat treatment the temperature of heating and the rate of cooling.

The final condition being a function of these two variables, it is easy to see the interest attaching to plotting a graphic representation of the result of a treatment by taking, for any given steel, these variables as co-ordinates. This method leads to the establishment of what may be termed the "characteristic curves" of the heat treatment of the steel in question. Such curves not only combine, within a single diagram, the fundamental data of every possible heat treatment, but they also afford a means of defining accurately the annealed and hardened states of the particular steel, and therefore constitute the basis and indispensable preliminary of every treatment properly carried out with a particular object.

In order that such a graphic representation may be plotted properly, it is necessary that the values from which it is built up shall be susceptible of numerical definition so as to be capable of measurement.

The method of evaluation of the rate of cooling and defining the final state was first described, followed by details of how the diagram of characteristic curves for heat treatments may be plotted, and it was pointed out that just as data is available with regard to the cooling capacity of liquids and gases, so there should now be plotted, with no less accuracy and for each type of steel, the curve showing the relationship between the rate of cooling and the effect of treatment, taking into consideration, more particularly, the part played by the second of the fundamental variables the temperature of heating.

It is to the question raised by the latter problem that the plotting of the characteristic curves can supply answers, as they combine, in a readily utilisable form, all the data furnished as to heat treatment and are the only means of ascertaining, with any degree of precision, the hardening capacity of a given steel.

Mechanical Properties in Relation to Carbon Content.

M. E. L. Dupuy, of Paris, described experimental investigations which had as their object the determination of the mechanical properties of steels in respect of their carbon percentages, at all temperatures between the normal and incipient fusion. Further, in order to ascertain what might be the influence of the size and orientation of the grains on these properties, experiments were carried out upon both cast and rolled material.

The experiments demonstrated that the following divisions could be made,

1. Below A1 (and having A2 as their limit!)
   Dead soft steel: ferrite which undergoes deformation by cleavage before fracture.
   Hypo-eutectic steels: only the ferrite undergoes appreciable deformation; fracture takes place when the pearlite areas come into contact with each other.
   Hyper-eutectic steels: brittleness due to the presence of cementite.
   Eutectic steels: fracture without almost any deformation.
2. Austenitic region:
   No matter what the carbon percentage is, the gamma-iron is entirely plastic.
3. Region comprised between A1 and A2.
   The plasticity increases with the proportion of gamma-iron.
4. Region comprised between A2 and A3:

Fracture almost without deformation owing to the low proportion of gamma-iron and the brittleness of iron in the beta-region.

5. Intervention of the liquidus:
Sudden and simultaneous fall in the breaking stress and the plasticity.

Hot Drawing on the Mandril.

Mr. Eugene Schneider dealt with hot drawing on the mandril. He gave a great deal of information showing how this operation can be carried out on a scientific basis instead of by merely empirical methods. He also gave some very useful practical hints.

Usually it is better to keep a little below the maximum elongation obtainable. If this is not done, various troubles may arise, caused by large differences in temperature. The slowing down of the press can produce breakdown or in case of limited power the blockage of the blank in the die and on the punch. The bottom of the blank may be staved due to the retaining of the temperature in this thicker region. This accident is specially to be feared with punches which are very conical at the end, and in that case it is advisable to keep well below the maximum elongation. A maximum elongation corresponding to the thickest part of the wall should be adopted.

The diameter may be smaller than that allowed for or there may be contraction of the mouth of the blank which is to be feared especially in the case of long and thin blanks where the section is very cold. Erosions and striation of dies are usually produced when blanks are at a low heat. The dies used should have as nearly as possible the ideal section indicated and should be very smooth and very hard.

Certain kinds of chilled cast iron with dressed surfaces give good results. The surfaces and blanks must be well cleaned outside and inside before drawing. The dies must be abundantly lubricated with black grease. It is well to heat them at low temperature before putting in service, and to be sure of their perfest support in the die-carrier.

The punches require every care both as to finish and to quality. The tensile strength should be 65 to 70 kg. per square millimetre, and tool marks or erosions should be avoided, as these greatly diminish their life.

The spraying after each press should be done regularly on all the surface and on the greatest length possible, in such a way as to avoid deformation.

Apply a mixture of tallow and blacklead, or of grease with blacklead, carefully over the punch before drawing, in order to prevent the blank adhering to it, and to facilitate the detachment.

When the blanks have very thick bottoms, it is necessary that the die should have a diameter slightly greater or equal to the external diameter of the bottom. It often occurs that when a blank is very eccentric it turns to the drawing without the die having touched it; of it is thick the torsion is often very important.

When a blank has an internal diameter appreciable larger than that of the punch, the rough blank must be treated very regularly; if not, the drawing tends to create more elongation in the hot part, which often diminishes the thickness and creates an eccentricity which did not exist before drawing.

Drawing in several dies simultaneously enable very large total elongations to be obtained. It is to be especially recommended in the case of blanks with very weak sides, and with some quick presses.

The pass must be divided out in such a manner that the work must be greatest at the first die and decrease successively on the others. This method of operation also allows the stroke of the press to be reduced and diminishes the wear on the last die, which has only light work to carry out.

Structure of Special Steels.

Three other interesting papers in addition to those summarised above were read at the Paris meeting. One of these was by Cononel N. T. Belaiew, C.B., on the marked analogy which exists in the structure and between some of the properties of high-speed and damascene steel; another by A. M. Portevin and M. Bernard on coalescence in steels and its commercial results; and the third by Mr. A. M. Portevin on some new constituents which he has found in the composition of tungsten and molybdenum steels.

The practice of annealing, followed by exceptionally slow cooling, is one of great interest from the point of view of researches on the structure of special steels. Treatment of this nature not only affords a means of securing a general enlargement of the structural features, so as to allow of a closer scrutiny of their details or peculiarities, but also leads to true states of equilibrium being obtained.

Structural Variations Resulting from Annealing.

An investigation of the structural variations resulting from annealing tungsten steels and then cooling them extremely slowly has led (in regard to alloys containing from 0.1 to 0.4 per cent. of tungsten) Mr. Portevin to certain conclusions.

The structure of these "normal" steels is described as consisting of ferrite associated with pearlite or even as being devoid of pearlite.

After annealing at about 1,300 deg. followed by a cooling extending over 75 hours, down to 200 deg., the structure is completely altered. In a steel containing 0.4 per cent. of carbon and 5.4 per cent. of tungsten which has undergone this treatment, there will be observed a network formed of light and dark areas separating regions occupied by a constituent differing from any hitherto known. This is apparently a complex, consisting of needles, and is met with alike in steels with a lower carbon percentage (0.1) and in steels with a higher tungsten percentage (7.55). Examined under high magnification there can plainly be seen needles arranged similarly to those of the martensite of hardened steels. These needles can be coloured by a solution of sodium picrate in soda. This characteristic added to their abundance in steels with so low a carbon content (which prevents them being taken to be carbides. shows them to be a tungstide. The arrangement of the structure shows them to have separated gradually from a crystallised medium, which is the solid solution.

Mr. Portevin has also succeeded in finding in molybdenum steels, similarly annealed, a constituents presenting the same morphological characteristics and susceptibility to etching as the acicular complex just described in connection with tungsten steels. Instead, however, of occurring as it does in the steel containing 0.4 per cent. of carbon and 0.5 per cent. of tungsten, in masses regularly distributed and forming the intersitial packing between a network or carbon complex, this constituent is found in irregularly disseminated clusters in a ground mass very readily colourable by acid reagents and hence more highly carbonised. These clusters are, moreover, visible to the naked eye owing

to the considerable enlargement of the scale of the structural arrangement, resulting from the very low cooling.

It is not possible to draw definite conclusions as to the chemical nature of these circular needles, which may be either an iron-molybdenum, or an iron-carbon molybdenum compound. Whichever they may be, the similarity between these structures in tungsten and molybdenum steels is of great interest, especially as the presence of these constituents indicates a state of equilibrium more stable than that previously encountered.

COL. CURRIE'S IRON FIND.

Further Proof of Intelligent Observation By Indians —And Exaggeration By the Press.

ALEXANDER GRAY.

Colonel Currie M.P. has a new iron ore area about twenty five miles north of Sprague, east of the Soo. It may not be as big as what they have in the northern tier of states over the border—notwithstanding exaggerated reports appearing in the daily press—but it is of sufficient importance to warrant drilling operations and has romantic antecedents to entitle Indians as keen observers to further credit marks as prospectors.

The Indian located the St. Eugene. The same is true of the Helen Mine. About sixty four years have elapsed since Herrick in running his lines with white assistants and Indian guides spotted the Helen—and it was about that time more "float" containing iron was noted. The Indians knew of it. Herrick's notes had references to it, as well as to the Helen indications. Gates took the Helen, when it was staked for him by the Indians—and Col. Currie declined another area offered to him for $500—a fact which he afterwards regretted.

For years the Colonel cherished a mental note about what he heard as to "float" north of Sprague. Having missed the Helen and the Magpie, he concluded another bunch of hematite ore low in phosporous would not be amiss. It happened, however, that conditions for prospecting were not altogether auspicious. Then the War intervened. Anyhow he waited and watched —and a few months ago he was willing to make the effort. Rather he retained Archibald M. Campbell, a Mining Geologist of Ottawa, to make the effort. Mr. Campbell was fortified with Herrick's 1857 field notes, which stressed the presence north of Sprague of a large quantity of boulders in which there was "excellent hematite iron". Other details as to the exact location were somewhat meagre.

But Mr. Campbell has hit a good many trails—and is familiar enough with the red man's lingo to make his way. So, off he went with his guides. In due course he picked up the essential Herrick lines. Then he worked into what had possibilities as iron country. Eventually he got the "float"—and manifestly it had not travelled far. Whence it came puzzled the geologist. Indian reports and Herrick notes had been verified. Beyond that Mr. Campbell was left to his wits—and those he exercised by examining the striae—the rock surfaces as marked by glacial action. Mr. Campbell called upon the glacial age to bear witness—and that led him across a lake where, in contact with greenstone on the hanging wall and quartzite on the footwall, the "find" of red hematite was made. Two-and a quarter miles was staked for Col. Currie and the samples taken are satisfactory.

There is "red iron", disseminated specular hematite, and more of the latter in a micaceous formation. According to Mr. Campbell, the iron is where it ought to be—yet he declines to concur in the newspaper tales about this being the precurser of another Gogebic or Mesaba Range. To the contrary, while hopeful, he declares there is no reason why the locality should be unduly magnified. Picked samples have yielded 68 percent metallic iron. The section between the greenstone and the quartzite is about half a mile in width. There is a possibility, owing to its purity, of much of the iron being recovered by concentration—and it is that feature which is giving those concerned most encouragement.

Mr. Campbell says "the truth is all we want. Fiction is misleading."

PRODUCTION OF PIG IRON AND FERRO-ALLOYS.

In Canada, August, 1921.

The quantity of pig iron and ferro-alloys produced during the month of August was nearly 4,000 tons lower than that of the previous month. Pig iron made by the firms for their own use dropped about 10 per cent or 5,828 tons below last month's figures. The output of basic iron was considerably higher, being 46,939 tons as compared with 40,720 tons in July. Foundry iron production decreased from 10,339 tons in July, to 1,882 tons in August. This decrease was entirely in that which was made for the use of the producing firms. Malleable iron also declined during this month, none of the firms reporting any of this product as being made for their own use, while 1,234 tons mas made for sale. There was but a slight falling off in the output of electric iron castings; last month's total of 105 tons being lessened by 4 tons. Pig iron made for sale during August amounted to 3,207 tons, which was an increase of 1,898 tons over that of July.

The reports of this month show that there were 2,547 tons of spiegeleisen produced. There is included in this amount 94 tons which was sold, this being the first sale of spiegeleisen reported since February. The several grades of ferro-silicon totalled 967 tons for August as compared with 659 tons during the previous month, a gain of 308 tons.

The Algoma Steel Corporation reported only two blast furnaces in operation at the end of the month, one having been blown out during the period. This loss leaves a total of five furnaces operating and fifteen idle at the end of August. The blast furnaces active were as follows: two at Sault Ste. Marie, one at Hamilton, and two at Sydney.

BENZOL SCORES A SUCCESS.

The enthusiasts of benzol will be gratified to learn that this alternative motor power scored a distinct success the other day in connection with the Aerial Derby, for we understand that the race was won upon a mixture of motor spirit and benzol. This important success lends considerable weight to the popular belief that an admixture of about 20 per cent. benzol with motor spirit tends to increase the efficiency of the internal-combustion engine. When one considers the phenomenal speed obtained by the fastest aeroplane in the Aerial Derby, the tip given above should certainly be worth following by motorists generally. —"Petroleum Times."

Drill Steel from Hollow Ingots

A Definite Effort to Produce Hollow Drill Steel With a Decarbonized Interior Surface by Inserting A Mild Steel Tube in the Ingot Mold, Plugging It With Sand, Casting the Steel And Subsequently Rolling to Size.

By P. A. E. ARMSTRONG
Vice President, Ludlum Steel Co.

Hollow drill steel is made by various methods: 1, The drilled billet with a sand-filled core, the general method used in this country. 2 The drilled, pierced, or the drilled and pierced billet, not sand-filled, is rolled down over a projectile or ball much the same as in ordinary pipe manufacture. System (2) is employed largely in Sweden. In Sheffield, England, the general scheme is sand-filling. Swedish hollow drill steel is particularly good and has a world-wide reputation for excellency.

It does not follow, however, that steels made by other methods are not efficient, because they are.

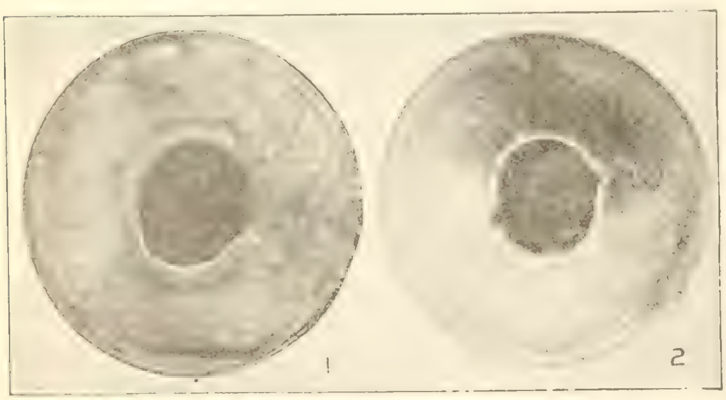
Decarbonized Centers in Swedish Bars.

In the Swedish material, a peculiar condition is present. The hole is badly decarbonized by the method of manufacture and the extent of this decarbonization varies in bars of different makes. Fig. 1 shows a polished and etched cross-section of very good grade Swedish hollow drill steel that is totally decarbonized 1-10 in. deep, and the carbon varies from the carbon of the bar down to iron or carbonless ferrite through another 1-10 in. Owing to difficulties in illumination, the altered structure is not so prominent as under visual examination.

Fig. 2 shows a much lighter decarbonized zone, being only about 1-40 in. thick, but with certain radial cracks running from the hole into the bar. In this photograph it will be noted that the body of the steel is very dirty. There are a large number of slag inclusions which follow somewhat the original form of crystallization.

Fig. 3 shows another section of Swedish hollow drill steel with about the same amount of decarbonization as Fig. 2, but with larger radial cracks, carrying the local decarbonization in more markedly than in Fig. 2. The zone of graded carbon content is about three times the width of that in Fig. 2.

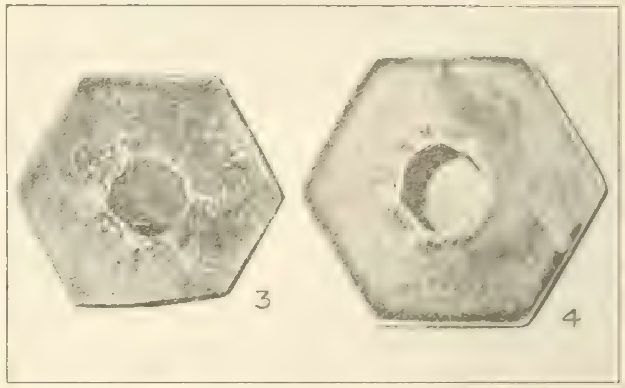
Fig. 4 is another sample of Swedish hollow drill steel, much about the same as the others, only with a little heavier decarbonization. All of the bars shown in Figs. 1 to 4 inclusive have been rolled either on a projectile or without one, but they were not rolled with sand in the hole and represent the general run of Swedish hollow steel.



FIGS. 1 AND 2. ETCHED CROSS-SECTIONS OF SWEDISH HOLLOW STEEL SHOWING MACROSTRUCTURES

Fig. 1. First-class hollow steel rolled over a projectile. Decarbonized zone 1/10 in. thick.

Fig. 2. Less clean hollow steel rolled over sand-filled. Decarbonized zone 1/40 in. thick.



FIGS. 3 AND 4. ETCHED CROSS-SECTIONS OF SWEDISH HOLLOW STEEL SHOWING MACROSTRUCTURES

Fig. 3. Badly cracked steel with thick region of graded carbon content.

Fig. 4. Heavily decarbonized rod of hollow drill steel.

Fig. 5 is a piece of 0.85 carbon. 1 per cent chromium steel rolled from an ingot cast around a mild steel tube. The mild steel lining has a thickness of about 1-40 in. and there are no cracks from the tube into the metal. There is a slight, but very slight, grading in carbon content between this tube and the metal. The reason for this is that chromium present in steel as an alloy prevents to a very large degree the carburizing of adjacent iron by saturation. I do not say that it is not possible to carburize mild steel by saturation because of the chrome alloy, but merely say it is more difficult than when the chromium is not present.

Fig. 6 shows a piece of 0.85 plain carbon steel having the mild steel tube core, cast and rolled in exactly the same way as that in Fig. 5, yet there is very little of the carbonless iron remaining. A very complete saturation has taken place, which shows very distinctly the difference brought about by the chromium.

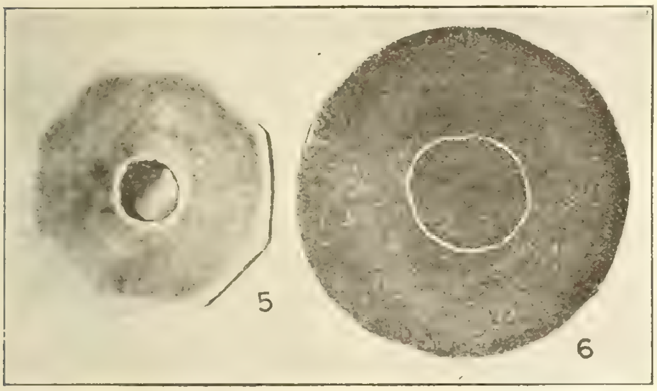
Influence of Decarbonized Layers on Hardening.

A question that seems worthy of deep consideration is this: Is this decarbonized core an advantage or a disadvantage? If it is an advantage, why not duplicate this by controlled practice and not haphazard means of manufacture? If it is a disadvantage, then why is it that steel of this character has such a good reputation for being a good grade hollow drill steel? There is nothing in the steel that can be discerned microscopically or by analysis that proves it to be superior to hollow drill steel of good manufacture made by methods that prevent decarbonization of the hole. Therefore it is fair to assume that the decarbonized wall of the hole is an

advantage. On investigating this subject we found that hardened bars with this decarbonized hole do not become so intensely hard on the inside, neither are they so prone to cracking. Bars with radial cracks are of course bad, no matter what the system of manufacture.

Attention is drawn to the fact that the decarbonized hole shown in the photographs, particularly in Fig. 1, has much greater decarbonized rim in the hole than at the exterior of the bar. This probably may cause some wonder. I believe it is due to the fact that on reheating the bars and rolling them through the various mills the oxide is broken off the bar. When the bar is reheated it is subject to a fresh scaling and is not affected by the scale already adhering to the bar which in itself would set up decarbonization. Therefore, the exterior of the bar has to withstand only the decarbonization arising from the furnace gases and later the adhering scale from that heating; whereas the inside of the tube is affected by adhering scale at all times, adding to the decarbonizing effect of the reheating. The scale is partly reduced by the carbon in the bar, and as the scale is thicker the action is more pronounced.

The mild steel or decarbonized iron inside the hole acts as a damping effect when hardening is produced. This effect can probably be readily appreciated when the fact is remembered that if a piece of, say, 1 per cent



FIGS. 5 AND 6. HOLLOW STEEL ROLLED FROM CHROMIUM AND CARBON INGOTS CAST AROUND A MILD STEEL TUBE

carbon steel be rough-turned so that all decarbonization is removed from the outside of the bar and this be heated up to just above the transformation point and quenched in water of, say, 70 deg., the bars will come out hardened in spots in a non-uniform manner. Some places will be hard; others will not. If a further length of the same steel be rough-turned and then ground and polished, this bar, subjected to the same heat-treatment and same speed of cooling, will come out quite file hard all over and not at all spotty. The reason for this is that the rough-turning holds the steam arising from the heated metal in contact with the water, and thus causes certain zones to cool at a slower rate than those places where the steam which is generated was quickly removed.

In the case of the polished bar, there is no roughened exterior to hold steam pockets, and the steam, as generated, quickly rises to the surface of the cooling fluid and the bar is uniformly hardened over its entire surface. If this bar, which is polished, were covered with a thin tube, then the hardening would not be very pronounced underneath the tube. This of course would vary with the thickness of the tube and whether or not the tube was in good contact with the bar. Such a condition can artificially be produced by decarbonizing the surface of this polished bar. If this decarbonization is carried to a fair depth, say 1-32 in., the bar will not be of maximum hardness underneath the decarbonized area after being quenched in water. The thicker the zone the less will be the hardness, and for the same reasons which prevent one from uniformly hardening a piece of similar carbon steel right through to the center when quenched from just above this is that the speed of cooling is only fast enough for a certain amount of penetration or depth of hardness. To harden right across the cross-section, alloy steels have to be resorted to, which have a greater lag to transformation.

Hollow Steel From Hollow-Cast Ingots.

Hollow drill steel made by casting the metal around a tube and mechanically working the hollow ingot down to the required size (filling up the hole with sand and later removing same after rolling) will have an artificially produced equivalent decarbonized core which will be free from any such tendency toward splitting and driving in radial cracks as has been noticed in the photographs. The surface of the inside of the tube will be comparatively smooth, giving a uniform cooling rate to the inside of the bar, again reducing the tendency for a radial crack to start.

One of the reasons why the carbonless walls of the tube of the bars made by this method do not crack in manufacture is because the mild steel tube is not the result of a decarbonized steel highly impregnated by oxygen and oxides and having a number of microscopical holes where the carbon of the carbides last resided. These holes are places of weakness which may or may not weld up, depending on whether the interior of these microscopical cavities is coated by an oxide layer or filled with gas, either from the gas occluded in this steel or that which has penetrated from the furnace atmosphere. Decarbonized steel is, in my opinion, less strong than mild steel which has been originally made in low carbon and worked down to the required size.

A mild steel tube, carbon about .15, is plugged at either end and filled up with sand. Hole is drilled through the tube and plugs but it is not pinned, the hole is left open. The tube is then inserted into an ingot mold which is recessed at the foot and a guide is fitted on the top of the tube, centering the tube with the ingot mold. This guide carries a pouring head. In pouring the ingot the hot metal is poured into the pouring head and the metal runs through four small nozzles down the four corners of the ingot mold and around the tube. The tube is cleaned well by sand blasting before being put into the ingot mold and a very excellent weld is produced between the thin wall of the tube and the hot metal. The tube being of mild steel has a higher melting point than the higher carbon of the molten steel, therefore although there is a surface weld between the molten metal and the tube, there is no tendency or very little tendency for the tube to burn through.

A large number of ingots have been cast by this tube method and not one has burned through. The holes drilled in the plugs are filled up by the molten metal which forms a pin to hold the plug into the tube and in the cast ingot.

Figure A shows a hollow cast ingot by the tube method which has been split on a planer without cutting through the plugs and the holes filled up with the molten metal forming pins can be clearly seen at each end. The smooth accurate shape of the hole can be readily appreciated from the photograph and attention is drawn to

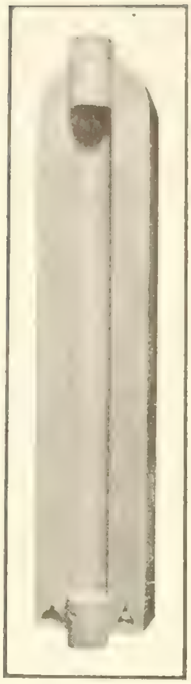


FIGURE A

the particularly small amount of pipe at the top of the ingot, showing the steel to be extremely free from gas. As can be seen from the photograph the weld is very perfect indeed down the entire length of the tube. The sand is not removed from the ingot after casting as this sand is employed for the purpose of maintaining the shape of the hole during rolling. The ingots are sent away to the 18'' mill furnace, reheated to required rolling temperature and the ingots rolled down to 3½ to 4'' square billets, depending upon the finished size of the bar. The method of cutting up billets is very interesting.

The shear on which these billets are cut is offset slightly so that the end of the billet is dragged down, thereby effectually closing the end of the hole of the billet, cutting out the necessity for plugging. The billets at this stage are just where the usual method of making hollow billets starts, the usual method being to take a 3½'' billet and drill 1 3-8'' hole down the entire

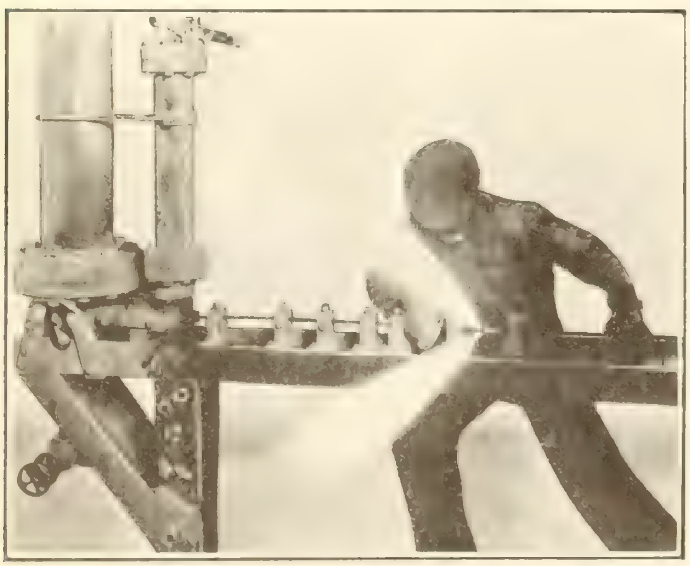


FIGURE B

length of the billet and plug other end of the billet after filling same with sand. The billets are then carefully inspected, chipped and ground to cut out any imperfections that may have arisen during manufacture, then sent to the 9'' heating furnace and rolled down on the 9'' mill to required size. The bars after inspection are topped and sent to the extracting room.

Figure B shows the machine in operation. High pressure sand blast is the method employed to remove the sand from the core or hole in the bar. The large tube to the right of the machine is the air reservoir carrying high pressure air and the smaller tube parallel with it carries fine sand which has an equalizing valve so as to maintain the same pressure in the sand canister as in the storage. As the air passes across the orifice at the bottom of the sand canister a quantity of sand is sucked down with the air and carried along the small tube which is inserted inside the hole of the bar. The cutting effect of this very high pressure sand blast is quite extensive. It is possible to wear away or drill a hole in a piece of steel by the action of this high pressure sand blast.

out the end of this small tube which does the trick. The usual method is to use an air blast but this operation is

Figure C shows the volume of sand and air coming

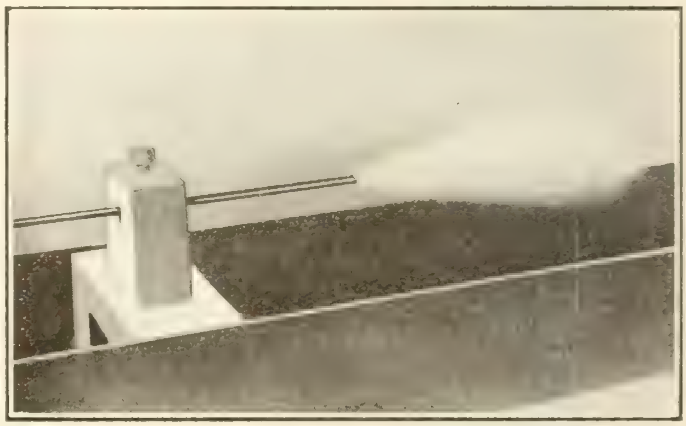


FIGURE C

not very speedy. Other method is to use water in the place of air known as the hydraulic method. This again is not so effective as using sand blast. Peculiarly enough there is very little wear on the inside of the tube carrying the high pressure sand blast as the sand is travelling in the same direction as the tube and the skin friction against the inside of the tube has the effect of driving the sand to the center of the tube and does not scour out the inside of this small tube which varies in size from ¼'' to 3-16''. It is possible to clean cut a 1¼'' rd. hollow drill steel bar, 20 ft. long by this method in about one minute.

This method of making hollow ingots and the method of removing the sand from the inside of the bar are covered by patents issued and applied for and is a very big step forward in economical and successful manufacture of hollow drill steel and hollow tubes and tubular bodies generally.

Segregation in Hollow-Cast Ingots.

Segregation is a thing which must happen in all steel solidification and this is responsible for a certain mechanical weakness in the finished bar. If the segregation can be so located as to have very little mechanical effect, it would be desirable to make the ingots in that manner.

Casting hollow ingots by the tube method is particu-

larly fortunate on this respect. As the segregation which is bound to occur will be concentric with the hole and its maximum occurrence is about midway between the exterior of the ingot and the tube wall, this area is very large in circumference, comparatively speaking, and the segregation is comparatively small because the distance between the tube and the ingot mold is small. This thin layer of segregation will be most noticeable at the top of the ingot. It can have no effect or at most very little effect upon the bar, as the segregates do not, under any circumstance, creep through to either the exterior or the interior wall of the ingot. Segregation is not removed at all in the pierced billets from solid ingots and is only very indifferently removed in the case of the drilled billets. Furthermore, even if segregated impurities are removed by using only the butts of the ingots, and drilling the billets, there is still carbide segregation to contend with. This will run in straight or nearly straight lines, parallel with the wall of the ingot or the line of freezing.

The inside of the hole of a drilled billet must, therefore, necessarily be the weakest place in the billet, resulting in a weak bar. Progressive fracture is easily started from one of these many sources of weakness.

Influence of Crystal Size on Quality of Steel.

Crystal size is of great importance. In a general way the smaller the ingot the better the steel. With a small ingot, the crystals are not very large, the crystallites or colonies of crystals not very far-reaching, and the speed of cooling from the liquid to the solid state fairly rapid.

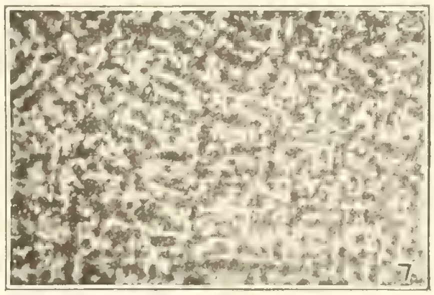
In a 24-in. ingot, for instance, the crystallites are likely to be quite large and likewise the individual crystals forming them. Crystallites are also apt to have a uniform direction for quite substantial distances, depending entirely upon the temperature and the speed of cooling. If the steel is cast hot enough and quickly enough, a fractured ingot will show a complete diagonal structure, the crystallites growing out like columns until they touch one another, leaving room for equi-axed crystals in the center of the ingot. If the temperature is lowered, the equi-axed zone is larger, and the pine-tree growth, which is the crystallite formation, is less.

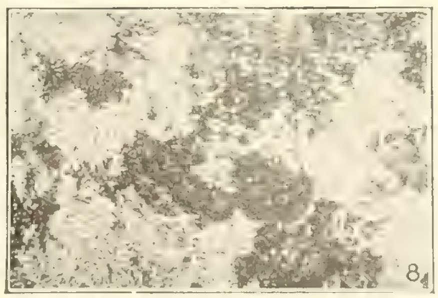
A small ingot, although capable of producing a very high-grade steel, is very prone to this columnar structure, even though the temperature of casting be kept down, and there comes a time when the ingots are very small, say 2 in. square or round or whatever shape is desired, when it is almost impossible to cast the steel in such an ingot without producing pine-tree growth complete to the center, and an ingot which is therefore known among workmen as "scorched". An ingot of about 7 in. size can be cast so that it is quite free from excessive pine-tree growth. Crystal formation, however, will be larger in a 7-in. ingot, cast solid, than where the 7-in. ingot is cast with a tube in it, as in the latter case one has all the advantages of a 2-in. square ingot with none of its disadvantages—the sand loaded core takes up the heat and prevents crystallite growth, besides preventing the formation of large crystals.

The speed of cooling after solidification is slower in the hollow ingot than it is in the solid ingot, therefore the granulation, which takes place after the crystals have formed from the liquid metal, is apt to produce larger grains than in the solid ingot. This is not a detriment. The original crystal size is of much more importance. The size of the grains due to this granulation constantly varies in response to mechanical work and subsequent heat-treatment.

I have found that the size of the grains arising from the granulation of the crystals does not grow larger than the size of the original crystal. Instances arise and should be carefully noted where the crystal boundary is broken and two crystals will appear as one, merely because the solution potential of both crystals are the same and therefore etch uniformly to the external boundary of the two crystals. This is more noticeable when these adjacent crystals have approximately the same orientation.

Two very interesting photographs, Figs. 7 and 8, appear to show conclusively that the casting structure remains in the finished bar. The analysis of this sample is: Carbon, 0.90 per cent; vanadium, 0.25 per cent; manganese, 0.30 per cent. This steel was heated to 1,340 deg. F., a temperature just about its known transformation point, held for some time and then quenched in water. The piece was 1¾ in. round made from a 7-in. square ingot, having a very fine structure in the broken fracture, extremely tough and, generally speaking, a very excellent piece of steel and for the tool for which it was used it gave some extraordinarily good results. Fig. 8 shows the structure as magnified 400 diameters, very fine, peculiar form of sorbite with troostite. Fig. 7 is the same piece magnified but 30 diameters. Here can clearly be seen the cast structure, which has remained in the bar right from the ingot. I believe that this piece of steel, generally speaking, will not have a crystal larger than the governing boundaries of the crystal from original casting. Naturally the crystals in this cross-section, which is at 90 deg. to the direction of rolling, will be smaller in that direction than when originally cast, although their total volume will be approximately the same.





FIGS. 7 AND 8. STRUCTURE OF VANADIUM STEEL ROD. PICRIC ACID ETCHING
Fig. 7. Magnified 30 diameters.
Fig. 8. Same region magnified 400 diameters.

Fig. 9 shows a piece of 3-8 in. square steel which was rolled out of a 10-in. ingot. It is a high-alloy steel and particularly prone to the formation of long crystals, meeting other along the diagonals of the section. Dur-

ing the mechanical work the crystal formation has become somewhat distorted. The structure of the bar, as seen by a fresh fracture, shows this piece of steel to have a very fine grain; the polished surface etched in the ordinary way shows the grain size to be small. The crystal size is not clearly defined at first, but on prolonged etching the crystal structure of the ingot is clearly shown, while the grain outlines arising from granulation of the crystal have been entirely obliterated. However, the inherent weakness of this steel is laid bare by the prolonged etching with weak acid. This bar is obviously weaker along the original diagonals. All steels will show the original ingot form in the same manner, no matter how far the working may be carried down; some steels have their crystalline structure more readily disclosed by prolonged weak-acid etching than others. It has often been noted that one bar of steel out of heat or a part of the heat will give very much better physical results than another bar from the same heat or out of a different heat, and this is to a very large degree due to the crystalline formation in the ingots. Fig. 9 very clearly shows the reasons for this condition.

Hollow drill steel made from a hollow ingot according to our method is, therefore, a little safer to use when overheating has to be contemplated as a possibility, as the ultimate grain growth will be less than a similar sized ingot cast solid, for the simple reason that the crystals were originally smaller. I do not want to infer that hollow drill steel so made can be overheated and that then the steel will give the same satisfaction as if it were not overheated. I am merely contending that it is slightly less harmful, the reasons being as given.

Surface Seaminess.

Surface weakness as shown by seaming and checking on the exterior when working the bars of hollow drill steel, or by cracking in hardening, is in some measure due to the surface stresses of the ingot when cast. We have found out that the temperature of the ingot mold or speed of freezing of the exterior of the ingot is of very great importance in this direction, and much seamy and cracked steel can be laid directly against a too quickly cooled skin. Ingots that are turned or milled all over will not seam very much in working, in fact they are practically free from seams, whereas an ingot rolled without a preliminary machining operation is full of seams and cracks, some long and some short.*

It has generally been said that these short seams and cracks in the surface of the bar are the result of elongated depressions in the surface of the ingot and that if an ingot is cast very smooth it should apparently give less surface defects. This is in some measure true, but an ingot cast very hot and having a very smooth skin will crack and seam very badly in the mill. The surface of an ingot poured very cold which is very crinkly, due to the low temperature of the metal, will seam just as badly. The cause of the cracks and seams in one is not the cause of the cracks and seams in the other.

Rough spots on the surface of the very slowly cooled ingot are elongated by mechanical work; roughened places continue to be pressed together, hence seams and cracks in cold-poured metal. In ingots cast very hot the pine trees or crystallites are separated by planes of great weakness at about 90 deg. to the surface of the ingot. These in themselves will cause cracks, the ingot then being known as tender. To draw the happy medium as a basis of our consideration and forgetting extremes, which are really of no moment, when comparing an ingot cast moderately hot so that it is not troubled with excessive dendritic structure and an ingot cast somewhat cooler and having about the same smoothness of surface, there is practically no difference in the amount of seaming and cracking, providing the ingot mold in both instances is cold or nearly so. If the ingot mold is warm, or thinner than usual, there is less surface strain on the resultant ingot and for similar surfaces there are less seams. Ingots cast with a tube in them seem to be freer from these surface stresses and the resultant billets do not have to be chipped or ground nearly as much to produce a bar free of seams and cracks.

The smaller the ingot the less will be the tendency for surface seams and cracks which may or may not develop. Those that do not develop may be thought of as locations of inherent weakness. Steel will shrink about 3-16 to ¼ in. to 1 ft. and the steel as poured

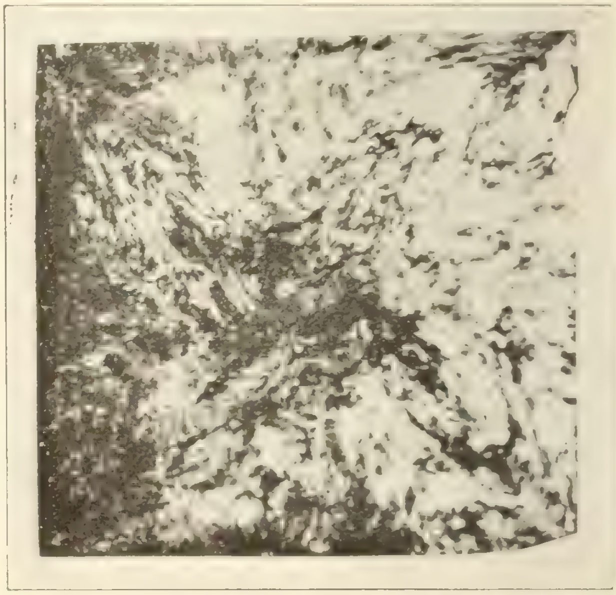


FIG. [illegible] ENLARGED MACROSTRUCTURE OF [illegible]-IN. ALLOY STEEL BAR ROLLED FROM A 10-IN. INGOT ENLARGED EIGHT TIMES

into the ingot mold will immediately freeze and contract to, say, one-half of the total shrinkage. As the inside of the ingot then begins to cool at a later time, the solid surface is trying to maintain a larger area than is demanded by the lower layers. The exterior of the ingot must then be crushed or the walls sink in, in which case it is under tension in a direction normal to the surface. If the ingot mold wall is concave the ingot when cooling will come practically straight, therefore the surface of the ingot must be under tremendous compression and just beneath the skin of the ingot or the depth of the first frozen layer the steel must be under tension, being held under constraint by the outermost layers, already in high compression. When the ingot is reheated it does not completely remove these strains, and when subjected to mechanical work the ingot will proceed to "let go" in various places—an action which will readily be conceded as being responsible in some measure for seams, cracks and defects of the character under construction. The smaller the ingot the less the actual amount of shrinkage.

In a hollow ingot cast by the tube method the hole is

* Reference is not made to the seams arising from over-felling or tapping.

increased in diameter by the freezing. The mild steel tube when heated up to the high temperature imparted by the cast metal is enlarged and continues to be enlarged until it reaches a maximum temperature. It then shrinks while the ingot cools, thereby relieving the exterior surface of the ingot from cracking, or having as much strain as a solid ingot. The mild steel tube will withstand this movement without giving away, whereas an ingot cast hollow but without a tube will not be very good, since the inside of the wall of the tube would be first under tension and then compression, and the metal would withstand these complex forces less well.

The tube method of making hollow ingots for the manufacture of hollow drill steel is a decided departure from the old methods, and the logic of it seems to show that the resultant hollow drill steel should be superior to that made by the older method. Tests made by the Ludlum Steel Co. to date show that such is the case; whether or not our premises are accurate, we believe that hollow drill steel made this way will withstand alternating stresses better than anything that has yet been produced of similar analysis. The reasons why we believe the tube method of hollow drill steel manufacture is superior to the older methods are:

1. Greater freedom from external and internal straining.
2. Because of the inherent small crystal size.
9. Absence of harmful segregation resulting in weakness of the wall of the hole.
4. Less liability for the steel to crack in the inside of the hole during forging or hardening.
5. Toughening effect, arising from the mild steel wall of the hole, limiting the intense hardening on quenching.

Watervliet, N. Y.

ENGLISH ELECTRIC COMPANY OF CANADA, Ltd.

Big developments are taking place in the electrical industry in Canada. The English Electric Company of Canada, Ltd., of which Mr. Gordon F. Perry, of Toronto, is President, and which includes among its directors many prominent financial men and captains of industry, is associated with the English Electric Company, Ltd., of Great Britain, is already established and has a continent-wide sales connection.

The Canadian Company holds the exclusive manufacturing rights in perpetuity for the English Company, having the use of all the latter's patents, designs and processes, etc. In addition, it will secure preferred prices on all imported machinery and equipment, also securing the benefit of the preferential tariff and the present favorable exchange rates. It acts as the agency for the English Company, which is the largest manufacturer of electrical and allied machinery and equipment in the British Empire, and, through it, all selling, engineering and construction work in Canada is done. It further holds the right to sell its own products in the United States.

Some idea of the scope of the operations of the English Electric Company, Ltd., of Great Britain may be gained from the fact that it maintains eight branches in the United Kingdom and ten abroad. Its activities are world-wide, and it is, naturally, exceptionally well placed to produce and sell the machinery, apparatus and appliances requisite for the adequate development of industries and underlakings, which have been delayed for the past few years. It controls and operates the Dick, Kerr Works at Preston, Eng.; the Ordnance Works at Coventry, Eng.; the Phoenix Works at Bradford, Eng.; the Siemens Works at Stafford, Eng.; and the Willans Works at Rugby, Eng. With the exception of the Ordnance Works at Coventry, all these are well-known as pioneers of the electrical industry in various branches.

By means of its association with the English Electric Company of Great Britain, the Canadian Company will be a progressive force in the electrical manufacturing industry of Canada. The increasing use of electrical machinery in all industries; hydro-electric power developments; the extending and re-equipment of our civic tramways and railways; the electrification of our railways; the equipment of our merchant marine with electrical engines; the increasing use of electric appliances of all kinds in the home; motor accessories; —all these will demand a huge amount of new electrical equipment.

Cooperating actively with the management of the Canadian Company are the Research Department and the heads of the Engineering and Construction Departments of the English Company.

It should be added that the entire undertaking of the Canadian Crocker-Wheeler Company, Ltd., of St. Catharine's, Ont., has been acquired, so that all the valuable patents and designs of this last-mentioned Company are available.

PRODUCTION OF STEEL INGOTS AND CASTINGS.
In Canada, August, 1921.

This month's production of steel ingots and castings, totalling 72,023 long tons, is the highest since November, 1920, being nearly ten thousand tons more than the amount produced in June, the previous record month of this year. The output of steel ingots showed an increase of 25 per cent or 17,698 tons over that of last month. Basic open hearth steel accounted for the increase, this month's total being 70,088 tons as compared with 51,111 tons in July, all of which was made by the producing firms for further use in their own plants. There was a falling off in the output of electric steel ingots, 246 tons being produced in August as against 523 tons in July.

The production of direct steel castings during August amounted to 1,684 tons which was an increase of 347 tons over July's total. Basic open hearth steel castings continued the advance made in July by rising to a higher level, 770 tons being produced as compared with 630 tons in July and 389 tons in June. The quantity produced for sale was 483 tons this month and 445 tons last month, while that made for further use, totalled 287 tons in August and only 185 tons in July. Electric steel castings increased 204 tons, the total for the month being 812 tons and for last month 608 tons.

Converter steel castings produced during the month amounted to 102 tons or three tons more than last month's total. The small percentage, 6 per cent (6 tons) was made for further use by the producing firms, while the balance, 96 tons was made for sale.

The record production of steel during the current month raises the average monthly production from 50,000 tons to nearly 53,000 tons. The average for the first four months of the present year was 45,000 tons, while that for May, June, July and August is 25 per cent higher, or 60,000 tons. It will be noted, by examining "Table 4 (b)" that the greatest production of steel during the first eight months of 1920 occurred in August.

Belcher Islands Ore Deposits

The discovery of important iron ore deposits in the Belcher Islands, Hudson Bay, has been commented on several times in these columns. Interested parties have had some very favorable reports on the deposits; but the published reports have not been very favorable, owing, possibly, to the poor impression the deposits made on one writer who visited the Islands some years ago.

Recently, however, one of the engineers who examined the deposits last year gave out some information in an article written for the Engineering and Mining Journal which would lead one to think that the possibilities of establishing an iron mining industry on Belcher Islands are quite good.

Mr. Dwight E. Woodbridge, the writer of the article is a well known authority on iron ore mining and his assistant Mr. Geo. H. Rupp is an experienced iron ore mining engineer.

Mr. Woodbridge says in part: During the summer of 1920 I made an examination of the iron formation of the islands, assisted by George H. Rupp, a mining engineer from Ironwood, Mich. That part of the islands examined consisted of the greater portion of the northern half of the group, roughly speaking lying north of Parallel 56, North Latitude.

Such a journey as I took to the Belchers is unusual and remarkable, for at present the only way to get there is by a roundabout course afforded by rivers large enough for canoe travel, and across the bays themselves. We travelled about 500 miles by canoe and 900 miles, all told, by small motor boat. Hardships and disasters, more or less serious, are sure to be met. There are dense fogs which, in those seas, never shadowing a sail nor beaten by a wheel, with no lights nor aids to navigation, are hazardous in the extreme; there are frequent storms, for these northern latitudes are subject to sudden and severe winds; there is ice, and to run into it from windward in fog or wind is death to a thin-ribbed, river-built motor boat. There is the actual wreck of these boats, perhaps, and the usual untoward incidents always to be expected during a trip into a new and distant region where there are no accommodations nor facilities of any sort whatsoever. But all these would soon be forgotten if the region were to be opened and connected with the outside world. They would make an attractive human-interest story, but are not necessary to a discussion of the mineral possibilities of the Hudson Bay region.

Iron-bearing formations themselves are not usually of a quality that will permit their use in the blast furnace; they are generally too low in iron and too high in silica or other inert or deleterious elements to be commercial. A process of concentration, natural or artificial, must take place. Sampling of the formation at the Belchers, this sampling extending over a length of many miles, showed it to be of a grade comparing favorably with the iron formations around Lake Superior in their entirety. The average iron content of the 125 square miles of the Mesabi district, for instance, is computed to be about 30 per cent iron: about 50,000 drill holes in the Gogebic have given an average of about 35 per cent iron. The comparable average of the Belchers is about 38 per cent iron, with all samples of 50 per cent or better excluded from the computation. In considering this newly discovered area and in comparing it with other and developed districts, one must be mindful that it is a wide extending formation, and not mines, that are the basis of comparison. A spade has never been put into the ground on the Belchers, nor has there even been sunk a drill hole. The whole study is one of geologic possibilities and similarities, with comparisons of the great mass of the iron-bearing formation.

At the Belchers the iron-bearing formation shows a thickness up to 400 or 500 ft. and can be followed along its eroded edges for many miles. My own work included fifteen miles of outcropping, running up to about 400 ft. in thickness. The formation is underlain by quartzites and early limestones and is capped by various recent lava flows, several different flows being discernible. The foldings and the erosions have cut through all these, disclosing greenstones, similar to those of the Lake Superior region, and it is not difficult to formulate an ideal cross-section of the various rocks.

Extensive areas were found in the formation where there had been sufficient concentration of ore to present faces up to 25 ft. in thickness of an average iron content of better than 52 per cent natural iron. The ore is very dense and close grained, blocky, breaking in rhombohedral blocks, reminding one of the Newfoundland ores under the sea at Bell Island, and the moisture content is extremely low, considerably less than 1 per cent. But not enough commercial ore was disclosed by my examination to permit a recommendation that the development of mines, the construction of ships, docks, and a railway, were warranted without further and considerable definite knowledge to be derived from exploration by drill or otherwise. It was reasonably safe to assume the actual presence of commercial ore in minable thicknesses up to a tonnage of not far from a million tons, but this was altogether too little on which to base the large expenditures necessary. It is enough, however, to base thereon a material exploratory campaign. If concentration of commercial ore in such a field, in minable thicknesses, is obtained, the probabilities are that there is vastly more to be found by search, and it is not impossible that on these islands exists one of the greater potential iron-ore fields of the world.

The only inhabitants so far north are Eskimos, and there are thousands of them in the tributary regions, up to Baffin's Bay and Chesterfield Inlet. They are a willing, kindly, trustful, hardworking and happy race, amenable to reason and discipline. This I found not only from my own observations, but from the unanimous consensus of opinion of those who knew them well. They live in daily fear of starvation, without the slightest semblance of comforts or knowledge of the amenities of civilization. True, they probably would not exist long if too much comfort was accorded them, but if properly handled and properly fed with the only supplies they are used to—raw sea products and such other food as is natural to their habitat—and if assured of life from which the fear of starvation and drowning were removed, it is probable that the labor supply would be ample and excellent.

The Eskimos are physically and mentally able. They have to be, or they could not survive. Their life is and always has been a constant struggle against the sea and the climate, and that they exist at all is proof of their adaptability and the sharpness of their intellects. One will note the same condition among northern Norwegians of the older type—that same struggle for life with the sea and the rocks, and their mental alertness

and characteristic aptitude are the results of conditions, not so severe though of like type, as those under which the Eskimos live. These people are so built physically as to warrant the belief that they would make excellent miners. It is fortunate that it is not necessary to consider Indians as miners, for there is as much difference in the mental and physical attitude of the two races as there is between an I. W. W. and a man working on his own.

No timber exists on the islands or on the mainland adjacent, but on James Bay, 100 to 150 miles south, the rivers are channels through magnificent forests of spruce, and as yet of no value at all. Mining timber should cost at the islands not a third of what it now costs in the Lake Superior region.

The possibilities of this newly discovered iron-formation region are truly interesting, and the more it is studied the more clearly do they stand out and the obvious objections fade away.

THE WALLACE BARNES CO. LTD.

The Wallace Barnes Company, Limited, of Bristol, Connecticut, so well known, not only throughout the United States, but also in Canada, as manufacturers of Barnes Made Products, wire and steel, has now opened a factory in Hamilton, Ont. This factory, formerly occupied by the National Machinery and Supply Co., is at this moment in operation. Mr. Truman M. Norton, for many years the Company's New England sales manager with valued business associations in this country, is secretary and treasurer of the new Company and is in charge of the Hamilton plant.

In its own particular line, there are few concerns on this continent which enjoy a more enviable reputation. Back of the Company, in the manufacture of springs, is an experience of sixty-five years, during which time it has been constantly looking forward, grasping new ideas and perfecting new appliances.

The Company specializes in small springs made of flat steel, of all gauges and forms; in spring washers and stampings made of high carbon spring steel; and in the solution of all spiral spring problems. Its clock springs are regularly supplied to some of the largest clock manufacturers in the United States. Its phonograph motor springs have been developed to a high degree of efficiency.

Its singularly complete equipment of furnaces for hardening and tempering, places the Company in an excellent position to do this class of work for trade, whether it is a small lot or a carload that requires treating.

NEW CRAWLING TRACTOR CRANE.

Industrial Works, of Bay City, Michigan, announce that they have augmented the crane family for which they are noted by the addition of the Type BC crawling tractor crane. They have developed this crane to meet the need for a full revolving tractor crane which can be developed independently of rails.

The crane is built in two types—the type BC with a capacity of 2,000 lbs. at 12 ft. radius equipped with continuous crawling tractor belts—the Type BT with a capacity of 18,000 lbs. at 10 ft. radius equipped with four broad gauge tractor wheels.

ACCURACY OF U. S. GEOLOGICAL SURVEY FIGURES ON MANGANESE RESERVES DENIED.

In advocating before Senate finance committee an increased duty on manganese, Chas. W. Potts of Deerwood, Minn., criticized report of Geological Survey on reserves of such ores, and declared the deposits would last as least as long as deposits of iron ores, which have been calculated would supply the United States demand for 2000 years.

He declared the reports of the Geological Survey were based on hurried and incomplete examinations of various fields. He cited that the survey listed total reserve supply of a certain grade in Arkansas district as only 2000 tons, whereas the companies in which witness was interested had actually mined 2500 tons last year and had only started on the deposit available. Butte district of Montana in the survey's report for 1915, repeated each year since then was said to contain only 2800 tons of manganese ore. Since then there have been 166,650 tons shipped from that district, according to other reports by the Geological Survey. Written parts of the survey report, he said, did not conform with tabulated figures of actual production.

Senator Penrose said he had a theory that 60 per cent or 70 per cent of the government's reports were worthless and large numbers of them had been returned to him with indignant protest against misinformation contained. He suggested this might be a subject worthy attention of the budget committee.

Mr. Potts said his investigation showed there were in this country 10,000,000 tons of high-grade or 40 per cent to 42 per cent manganese ore, 20,000,000 tons of 25 per cent and 30,000,000 tons of lower grades, all of which could be used in the steel industry.

George H. Crosby, whose business it is to explore for and discover minerals in Minnesota and Wisconsin ranges, also expressed amazement at inaccuracies of Geological Survey's report and said that if the manganese industry were properly protected, 75 per cent of all needs of this country could be produced here. Only one-eighth of possible productive area in Minnesota has yet been developed, he said.

WESTINGHOUSE CO. GETS BIG CHILEAN CONTRACT.

(Special Despatch to The Globe)

New York, Sept. 29—Westinghouse Electric International Co. has announced that it has received final confirmation of the contract to supply the equipment for electrifying the Chilean State Railway between Valparaiso and Santiago and to Los Andes.

The contract covers the most important railway electrification since the beginning of the war and the largest ever undertaken by an American firm outside of the United States. The main line, which is 116 miles long, and is now under steam operation, is the most important in Chile. It connects the leading seaport, Valparaiso, with the Capital, while the line to Los Andes is 28 miles long, and forms the Chilean end of the transcontinental line to Buenos Aires.

The contract, which has a total value of $7,000,000, was secured in spite of keen competition from German and other European concerns.

A Solution of the Titanium Problem

By FRANK LYMAN MacCALLUM, Kingston, Ont.

Our present total neglect of the titaniferous ores of iron is the more surprising when we consider what advantages they offer. Many of the deposits are most attractive as to situation and size. Their iron content is often 50 per cent or over, which at least equals the average of ores now passing through the Soo. With titaniferous ores it is exceptional for phosphorus to exceed the Bessemer limit of one one-thousandth of the iron content, or for sulphur to reach more than a trace. So the pig from these ores would be excellent for conversion by the acid Bessemer process, which is the cheapest method of making steel. Moreover, they always carry vanadium which, if it could be kept with the iron throughout, would be of great value in producing alloy steel. Titanium itself is a useful adjunct in making sound steel and castings, many tons of ferro-titanium being used annually for this purpose.

In all these ways the tendency is to obtain from titaniferous ores a high-grade product at low cost.

History.

Their commercial employment would not be an innovation. For centuries they were used at certain European forges and the product had a reputation for lasting excellence. Good results were also obtained from their treatment in forges in the United States. But with the introduction of the blast-furnace they fell into disuse, as ores better suited to the new process were at that time abundant. Nevertheless they were employd to a limited extent. A blast-furnace ran from 1840 to 1846 on titaniferous ore from the Sanford Hill deposit, and only financial difficulties led to its being closed down. In 1868, Dr. Forbes successfully smelted Norwegian ilmenite in a blast-furnace at Norton, England, but failed to make it pay. Later Dr. Rossi made a run in an experimental blast-furnace and produced good iron and fluid slags, in spite of difficulties in the operation of so small a furnace. In recent years, also, there have been two large-scale tests in blast-furnaces, one at Port Henry, N.Y., in 1914, and the other in 1918 at Patea, New Zealand, the ore in this case being magnetic sand.

Unprofitable.

These attempts have made clear two points: (1) That the blast-furnace can successfully reduce iron-ores containing as high as 40 per cent of titania; (2) That financially, the results have been disappointing.

This second fact is not strange when one considers the chemical composition of these ores. They are generally quite silicious, and the large quantity of limestone required to flux both the titania and this silica cause competition with moderately silicious, titanium-free ores, impracticable. This is the real and sufficient cause for their unpopularity. Moreover, slags containing titanium are sometimes sticky, and in inexperienced hands have caused trouble and disaster. Hence the reputation of these ores has become so sinister that the average furnace man would not touch them with the proverbial ten-foot pole.

Not long ago, a blast-furnace manager accidentally discovered that an excellent ore he had been using for years contained eight or ten per cent of titania. When he mentioned this curious fact to the shipper, the latter was horrified. "Keep it dark, for God's sake," he begged.

Theory.

In 1919, the Honorary Advisory Research Council of Canada granted its support to a study which was being conducted at Queen's University, Kingston, Ontario, for the purpose of finding a method of treatment expressly suited to the peculiar requirements of titaniferous iron-ores. The development of suitable slags has been made the objective, on the principle that, "The production of a high-grade slag means the production of a high-grade pig iron."

It will be recollected that in Mendelejeff's periodic arrangement of the elements, those at one side of the table are basic in their tendencies, acidic at the other and in the centre amphoteric, able (theoretically at least) to act either way according to conditions. Calcium and magnesium, of the gangue-forming lements, are on the basic side, with aluminum inclined that way. Titanium and silicon are in the central group, but actually the latter has a decidedly acidic tendency and only titanium is truly amphoteric.

Hitherto, titania has always been grouped with the silica as so much acid and fluxed by adding corresponding amounts of lime. But in the presence of a sufficiently high proportion of acid, titania ought to act as a *base* and serve *instead of* a corresponding amount of lime in forming a slag. Hence, by using silica instead of lime as the fluxing agent, the titania should be induced to join with such magnesia and lime as are contained in the gangue, and the whole flux satisfactorily. As these ores already contain a good deal of silica, the addition of very little — if any — more brings about the required balance.

Practice.

Pot tests and investigation under private auspices having convinced the experimenters that there are slags consisting essentially of silica, titania and alumina, preparations were made for a number of runs in a small electric furnace.

A two-ton lot of titaniferous magnetite was crushed, sampled and analysed with the following results.

Analysis of Iron Ore.

Fe_3O_4 (assumed)	66.59%
SiO_2	7.40
CaO	3.42
MgO	4.73
Al_2O_3	5.81
TiO_2	11.80
MnO	0.36
	100.11%

* Based on, "The Smelting of Titaniferous Iron Ores," By W. M. Goodwin, Transactions of the Royal Society of Canada, Vol. 13, June 1921.

A half-ton of common building-sand gave the following partial analysis.

Analysis of Flux. (Sand).

SiO_2	69.0%
CaO	10.30
MgO	2.64
Al_2O_3	8.29
	90.23%

Hardwood charcoal was used as reducing agent and assumed to contain one per cent or less of ash.

Some slags which had proven satisfactory in earlier tests, (run empirically on charges of half a ton) were analysed with the following results.

Slags Iron Former Tests.

No.	B 31	B 33
FeO	2.30%	3.96%
SiO_2	42.25	36.61
CaO	6.85	7.55
MgO	9.19	10.29
Al_2O_3	15.23	16.61
TiO_2	20.80	22.55
MnO	0.80	0.70
C	0.60	0.20
	98.02%	98.47%

On this basis the furnace charge was calculated tentatively at 20 lbs. sand and 25 lbs. charcoal to each 100 lbs. of ore.

The furnace — a small iron-box lined and roofed with silica brick round a nine-inch crucible — was first thoroughly heated by passing the current through a bed of charcoal. Then ore, charcoal and flux were fed between the electrodes, slowly enough to prevent undue chilling.

Approximate Temperatures of the Runs.

Run.	Temp. on Stream of Slag.	Temp. on Furnace Lining.	Nature of Slag.
I.	2380 F. = 1304 C.	2480 F. = 1360 C.	Fluid.
II.	2200 F. = 1204 C.	2400 F. = 1315 C.	Fluid.
III.	2600 F. = 1426 C.*	2420 F. = 1326 C.	Very fluid.
IV.	2530 F. = 1388 C.	2480 F. = 1360 C.	Slag fluid. Most of iron "Frozen" on bottom.

* Reading them on bubbling slag around electrode before pouring.

The temperatures here recorded are each the average of several readings taken with an optical pyrometer. The readings on such small streams of slag are obviously unreliable. Those obtained by sighting on the furnace lining just after pouring are much less so, but are also open to doubt, since the temperature of the container is not necessarily that of the contents. However, they all compare most favorably with the average temperature of the stream from the blast furnace, which is 1,450 deg. C.

The following tables show the product of four runs, S representing the slag and P the pig. In the fourth run the furnace was chilled by too rapid charging, and only an imperfect separation of iron and slag took place.

	Analyses of Slag from Runs				Typical Commercial Slags		
	S1	S2	S3	S4	(a)	(b)	(c)
FeO . . p.c.	2.9	4.0	3.7	3.1	..	..	3,46
SiO_2	44.5	35.3	35.6	36.2	33.	35.	26.72
CaO	7.0	6.-	8.1	8.4	41.	40.	25.81
MgO	13.2	12.1	10.8	10.6	11.	5.5	5.99
Al_2O_3	13.8	17.5	15.9	16.9	12.	13.	11.86
TiO_2	17.4	26.1	25.6	21.7	..	..	25.1
MnO	0.3	0.3	0.6	0.4	..	..	..
p.c.	99.1	101.4	100.3	97.3			
Fe (assumed)				5.0			
				102.3			

(a) Average iron blast furnace slag, after Bradley Stoughton.
(b) Average iron blast furnace slag, after Field and Royster.
(c) Typical blast furnace slag from titaniferous ore. (McIntyre furnace, Adirondacks.)

A comparison of the two groups in the above table brings out the difference between the ordinary blast-furnace slag and the new slag. In the latter, titania has taken the place of a major part of the lime of the former. This is the feature that makes this slag different from those used heretofore.

Despite the high silica content of S1 — produced by corrosion of the new lining — it was normally fluid. Several experiments have led to the same conclusion, namely, that these slags remain fluid through a considerable range in composition.

The extent to which this slag will dissolve phosphorus and sulphur has not yet been determined, but it is certain to be very much lower than that of slags containing much lime. But, as has been pointed out, most titaniferous ores carry only negligible amounts of those twin plagues.

	Analyses of Pig Iron from Runs				Standard Pig Iron			
	P1	P2	P3	P4	Foundry	Forge	Basic O.H.	Acid Bessemer
C.	2.53	2.53	2.56	3.04	3 to 4	3 to 4	3.5 to 4	3.5 to 4
Si.	4.99	3.91	1.28	1.90	2.75	0.75 to 1.75	Under 8.00	0.80 to 2.00
Ti.	0.02	0.02	0.01	0.01	....	....	....	....

This iron should be suitable for some foundry purposes, but its greatest use would seem to be for conversion into steel.

Self-Fluxing Ores.

A comparison of the analyses of these new slags with those of the gangue materials in a number of titaniferous ores, discloses a striking similarity of composition. In not a few cases, these ferro-magnesian silicates are present in the right proportion to make the ore self-fluxing.

Analyses Indicating Self-fluxing Ores.

	I.	II.	III.	IV.	V.	VI.	VII.
Fe	49.8	44.5	48.5	38.8	40.5	59.6	2.55
SiO_2	27	30	31	33	37	34	35
CaO	8	13	14	7	9	8	6
MgO	11	6	13	8	18	12	12
Al_2O_3	16	13	15	21	8	12	18
TiO_2	37	38	25	31	28	31	26

I. Chaffey Mine, Ontario.
II. Pine Lake deposit, Ontario.
III. Millbridge, Hastings County, Ontario.
IV. Seven Islands, Quebec.
V. An Ontario Deposit.
VI. A Newfoundland Deposit.
VII. Slag S2, (for comparison).

The first six columns show analyses of various titaniferous ores, with the gangue materials reduced to the percentages they would form in the slag. Column VII shows the analysis of a typical titania slag, S2. Ore V is self-fluxing by actual trial, though the deficiency of alumina seems to make the slag a little sticky. These self-fluxing ores need only reach 40 per cent in iron for the furnace burden of iron to equal or exceed the average in North American practice.

As many of the deposits grade by degrees into rock, the proportions of slag-forming materials could be adjusted at will by including more or less of this marginal phase. In other cases it would be possible to add highly-silicious iron-ore as flux.

Thus, instead of being the great handicaps they are in regular blast-furnace practice, silica and titania become prime necessities. Here, it is hoped, is the germ of a radical yet sound departure in the commercial smelting of iron.

Some Iron Ore Occurrences in British Columbia

The Bull River Deposit.

The largest deposit of hematite iron ore known in British Columbia occurs on Fenwick Mountain, East Kootenay, within five miles of Wardner and nine of Jaffray (both stations on the Crow's Nest branch of the Canadian Pacific Railway), and within fifteen miles of Elko where the Great Northern Railway is operating its line from the Fernie and Michel coal fields to Rexford, Montana.

The property derives its name from Bull River which runs at the foot of Fenwick Mountain; and consists of eight claims of about 50 acres each embracing all the surface exposures of hematite on the summit of the mountain.

The eight claims are held in fee simple having been Crown granted.

The general structure of the iron-bearing zone is a banded one, bands of iron varying in width from two to eight feet, separated by a barren parting of from 6 inches to one foot; the barren partings are sometines replaced by a low-grade iron ore carrying from 20 to 45 per cent. metallic iron. The bands of iron are continuous in length and width and show no indications of being lenses or pockets.

About $8000.00 has been spent in running tunnels and stripping the surface. The ore may be divided into three classes as follows: A hard, blue, hematite, slightly schistose in character; and a soft surface-ore.

A series of analyses taken from all the claims resulted in an average of 8.52 per cent. residue, 8.58 per cent. alumina, 1.56 per cent. lime, 1.10 per cent. magnesia, 0.062 per cent. sulphur, 0.0282 phosphorus and 61.35 per cent. metallic iron.

Sufficient development work has not been done to estimate the amount of ore, but enough has been done to prove the surface area of the iron-bearing formation or veins both as to length and width.

A spring and a small lake on the claims furnish enough water for domestic purposes. There is a sufficient supply of timber for mining purposes.

The development work done on the claims has defined the course and dip of the deposits but no attempt has been made to determine the depth to which these deposits extend. This could be cheaply and quickly done by means of a diamond drill. Judging from the outcroppings of the ore the lowest to the highest points exposed measuring 900 feet, it is probable these deposits will be found to continue with depths. The contour of the mountain is such that the deposits could be worked to advantage by the open-cut method.

The Sand Creek Deposit.

In a report prepared for the B.C. Dept. of Mines, the Resident Mining Engineer for East Kootenay, Mr. A. G. Langley, says of the well known Sand Creek iron property as follows:

Preliminary exploration has disclosed a vein of hematite running in a north-westerly direction along the south side of Sand Creek. Three claims have been staked along the strike of the vein and are known as the Pearson group, being owned and staked by the present owner, W. Pearson.

Leaving the Fernie road at Jaffray it is possible to drive by motor within six miles of the property. A good trail is then followed up the creek. The claims are easily accessible and a road-grade of not exceeding 3 per cent. is obtainable from Galloway to a point on the creek immediately below the exposures, which are situated at an elevation of from 400 feet to 600 feet above.

The valley of Sand Creek in this vicinity is a beautifully wooded country of timber, principally represented being white pine, hemlock and cedar. On account of the rock outcroppings being covered with overburden, it is only possible to form a very limited idea of the geological structure, or the formation, which apparently consists of quartzites, probably belonging to Cambrian age, and having a dip of 50 degrees to the south-west and a strike of N. 50 degrees W.

The ore, consisting of a massive red hematite, occurs as a bedded fissure-vein replacing the quartzites. The hanging wall is well defined, but on the footwall side the ground is broken and crushed, and in places stained with the characteristic red color of the ore.

At the most southerly working, at an elevation of 4000 feet, a deep open-cut crosses the strike of the vein and terminates in a short tunnel. Here the formation seems to be broken over and the ore, which is more or less crushed, does not appear to be in place, but to have slid over from a higher point up the hill. The ore shows the width of 3.5 feet of a massive red hematite, a sample across which ran: Metallic iron, 51 per cent.; silica, 22 per cent. phosphorus, nil; sulphur, nil.

At a slope distance of approximately 120 feet above this showing a diamond-drill hole was put down by Dr. Ings, of Calgary, some years ago, but no record of work

[illegible] of hematite extracted. The ground here is broken at the surface and the tunnel is not of much consequence [illegible].

Continuing along the side-hill for a distance of about 300 feet, the northerly workings are reached. Here at an elevation of 4,300 feet a short-cut shows a section of the vein to be in-place. The dip, conforming to that of the enclosing strata, is 50 degrees to the south-west and strikes about N. 50 degrees W. The hanging wall of the quartzite is well-defined and there is a good selvage between it and the ore. On the foot-wall side adjacent to the ore, there is a band of about two feet talcose material, and general conditions would indicate that the country-rock has undergone more crushing and alteration on this side of the vein.

The ore is a well-defined band of red hematite lying next to the hanging-wall and having a width of 12 inches, across which a sample ran as follows: Metallic iron, 57.4 per cent.; silica, 15.6 per cent.; phosphorus, nil; sulphur, nil. Although the samples taken show the ore to run rather high in silica, it is undoubtedly of good grade and should a good workable width be developed the mining costs for this class of ore should not exceed $2.00 per ton.

The hillside, sloping at an angle of 30 degrees, affords a number of good tunnel sites, and a depth of 400 feet on the vein could be obtained by cross-cutting from the surface. There is a good camp site with plenty of timber and water, while power might be developed from Sand Creek, which has a flow of about 4 second-feet during the dry season.

It is not unlikely that there may be other parallel veins in this formation, and although the vein is small the good quality of the ore and the easy accessibility of the property are strong factors in its favor, while the possibilities from a geological standpoint appear to warrant further work being done to prove the existence of a sufficient body of ore to be of economical importance.

The preliminary work should consist of trenching and open-cuts along the strike of the vein; then if the results are favorable, a diamond drill might be employed to advantage.

INCREASE IN WATER POWER.

In his address as president of the Engineering Section of the British Association, Professor A. H. Gibson gave a survey of the water-power resources of the world, and discussed some of the problems associated with their developments. He pointed out that two-thirds of the water power now in use has been developed within the last 10 years. Thus France has put some 850,000 water h.p. into commission since 1915, and now has 1,600,000 h.p. under control, as compared with 750,000 before the war. In Switzerland some 600,000 h.p. has been developed since 1914, or is in course of construction, as compared with 880,000 before the war. In Spain the pre-war output was about 150,000; now it is 620,0000 and about 260,000 is in course of development, while the Government is considering the development of some 2,000,000 h.p. to be delivered into a network of transmission lines covering the industrial parts of the country. In Italy schemes totalling 300,000 h.p. are under way, and it is estimated that the [illegible] almost 20 per cent. of her available resources. In Canada the total development in 1918 (2-3 million h.p.) was nearly three times as great as in 1910, and in the United States the development has increased from under two millions in 1901 to 5-3 millions in 1908 and nearly 10 millions in 1920.

CYCLONE FENCE CO.

Hamilton Has Secured Another Important Industry.

The Cyclone Fence Company, Limited, of Toronto, is the latest American concern to establish a branch in Hamilton, according to an announcement made by W. Kirkpatrick, industrial commissioner, this morning. While an entirely separate Canadian company, it is in reality a branch of the Cyclone Fence Company, of Waukegan, Ill., a suburb of Chicago. Negotiations have been in progress for some time and were concluded during a recent visit of Mr. Kirkpatrick to Chicago and other western cities. Competition for landing the Canadian branch was keen.

The Cyclone Company is the largest manufacturer of ornamental and industrial wire fencing in the United States. It was established a number of years ago on a very limited scale, but its growth has been steady and substantial, with the result that it is to-day capitalized at $1,500,000, and is doing approximately $5,000,000 worth of business annually.

Asked for the reasons for selecting Hamilton as the company's Canadian location, J. P. Arthur replied: "Our reason for selecting Hamilton as a location is that it appears to be very centrally located for our business, which will be national in scope.

"We also have been well impressed by the very clean looking appearance of the city in the business manufacturing and residential districts. Also there has appealed to us the apparent opportunities for the housing of workmen and in that way keeping their morale up to a high standard."

For the present the company will not build a plant of its own, having taken a lease on part of the plant of the old Canadian Cartridge Company, on Sherman avenue north, which it will occupy until building conditions become more normal. The installation of machinery will commence about the middle of this month, and it is expected that all will be in readiness for manufacturing operations to be started about November 1. In addition to employing about 100 hands in its local factory, the Cyclone Company will furnish employment for a number of men in several other local industries, as it intends to purchase its raw materials and material supplies, as far as possible, in Hamilton.

AMERICAN SOCIETY FOR STEEL TREATING.

The third annual convention of the American Society for Steel Treating was held at Indianapolis Sept. 20-23. The attendance was very large. Sessions were held on carbonizing tool steel, heat-treating, alloy steel, nonferrous metals, and on equipment. Mr F. P. Gilligan of the Henry Souther Engineering Co. Hartford succeeds Lt.-Col. A. E. White as president.

Dr. John A. Mathews of the Crucible Steel Co. and Elwood Haynes of Kokomo, Ind. have been elected honorary members of the American Society for Steel Treating. Mr. Haynes is well known in Canada for his work in connection with alloys.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

ZIRCONIUM.

On account of various mysterious properties and uses that have been attributed in the popular mind to zirconium, it has at times been styled "the mystery metal," says the United States Bureau of Mines. An investigation regarding the preparation and uses of metallic zirconium and its salts has been conducted by the Bureau of Mines, and the results are just now made public.

The compounds of zirconium have numerous important uses and more uses will doubtless be found. Investigations in recent years have indicated that sintered or coherent zirconium metal is very resistive to acids; that it can be used for electrodes, and it probably will find metallurgical uses. A steel containing zirconium has been proposed for use in armor plate and automible parts, and nickel-zirconium alloys have been suggested for high-speed cutting tools and for cutlery. Numerous articles in scientific journals have recommended the use of zirconium oxide as a refractory, an abrasive, a pigment in paints, and as an opaquing agent in enamel ware. The salts have been used in the textile industry as a mordant or dye-fixing agency, and also for weighting silk.

Zirkite fire brick are used for furnace lining as well as for other purposes where a refractory having a low coefficient of expansion, high melting point, and maximum resistance to slag corrosion is demanded. Although zirconium oxide has not proved satisfactory for gas mantles nor for arc lamps, it has been used for polishing powders, insulators for both heat and electricity, and with fair success in the Nernst lamp. Being absolutely non-poisonous, zirconium oxide is finding a use in paints and lacquers, where its resistivity to physical and chemical agents is proving highly valuable. As an abrasive, zirconia, zirconium silicide and zirconium carbide are suggested for a variety of uses, the carbide particularly as a substitute for the diamond in cutting glass. Zirconium oxide, because of its non-toxic nature, is used in place of bismuth, nitrate or carbonate in Rontgen-therapy. It is also said to have some medicinal value. Zirconium oxide and nitrate have been suggested for use in the extraction of oxygen and nitrogen from the air. There have also been statements to the manufacture of rubber goods.

In flash lights, amorphous zirconium, mixed with certain oxidizing agents, burns with a bright light; but it is doubtful whether the metal would be cheap enough to use in place of the usual material. Coherent white zirconium metal, on account of its acid-resisting properties, has been suggested as a substitute for platinum in certain cases. Its alloys have been suggested in the manufacture of rust-resisting apparatus. Crucibles prepared from zirconium oxide were proved in the experiments of the Bureau of Mines to be superior for high temperature work to any crucibles procured on the market.

Zircon is found in considerable amounts in many placer deposits derived from disintegration of granitic and pegmatic rocks. The best-known deposits in the United States are near Green River, Henderson County, N.C., and in the Wichita Mountains, near Cache, Okla. Zircon is found most abundantly in certain syenites of Norway, and occurs in crystalline limestone at Grenville and elsewhere in Canada.

In Brazil, which is an important source of industrial ores, it is difficult, owing to the hardness of the ore to drill holes for explosives, and in handling large amounts resort is had to quite primitive method. A large fire is built against an exposed face of the ore and kept burning for several hours, at the end of which time water is thrown upon the ore, which produces fracturing of the mass, permitting it to be sledged into pieces easily handled by one man. Most of the mines are many miles from the railroad. Horses for other than saddle purposes are practically unknown, and the ore is transported to the railroad station by oxcarts carrying about 1 ton each. These carts are of the crudest character, having large, solid, wooden wheels, some 4 feet in diameter and 6 inches in thickness. From 20 to 30 oxen are generally required for each cart, owing to the mountainous roads.

The results of the investigations of the Bureau of Mines are available in Bulletin 186, "Investigations of zirconium with especial reference to the metal and oxide," by J. W. Marden and M. N. Rich, which is distributed by the Superintendent of Documents, Washington, D.C., at a price of 25 cents.

B. C. GOVERNMENT AIDS DEVELOPMENT.

Usk, B.C.—On the Peerless Group, Kleanza Ck., tunnels and stripping have revealed ore in the form of bornite and chalcoctite copper magnetite and manganese oxides. An adit was started to get under the largest body of ore but was not completed. A camp is being constructed on the Silver Horde at the head of Chiminess and Kleanza Cks, where there are bodies of ore in which grey copper predominates and which contain high silver values. The Provincial government is doing some road construction in this district that will materially aid in the development, through provision of transportation facilities, of these and other prospects.

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OF CANADA

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COAL AND STEEL.

"Iron Age" in a recent issue states "The high cost of coal is undoubtedly a great impediment to industry. If cost has anything to do with consumption, and that is an accepted argument as to most commodities and as to freight rates, the high cost of bituminous coal is certainly a great drag upon industry. The price of coal f.o.b. mine is a serious concern to practically every one, for all are consumers of coal. There is no other article of commerce whose cost is so widely felt. ...At present the ambition of the union miners seems to be to charge the public, after April 1st 1922, with back pay for the time they have been idle of late, as well as for the time they may lose in a strike. This is a matter of the greatest concern to the public."

To no portion of the public is it of greater concern than to the remainder of unionised labour, as it is the high cost of coal that is the greatest obstacle to reduction of railway freights and general resumption of manufacture. Coal is the last great staple that is out of line with other commodities when compared with pre-war figures. The miners appear to have made up their minds that coal can be maintained on its giddy pinnacle, but they must inevitably discover that it cannot. The English miners had the same idea, but after testing it out they have freely and fully recanted their economic heresy. The revival of trade in Britain, the resumption of manufactures and exports, and the rise of sterling, are all results of a return to a more normal alignment of coal among other commodities in Britain. Coal is certainly "out of line," and so long as it remains out of line, business will stay out of joint.

Nor must it be forgotten that provision for employment for the steel workers—an industry just beginning to show appreciable signs of recovery—is dependent upon the coal trade, and that the keeping open of the mill can only be rendered possible by the reduction of wages in the mines. On this point Mr. Roy M. Wolvin, the president of the British Empire Steel Corporation, very properly laid special emphasis in the course of an interview in Montreal the other day in which he indicated the possibility of the mines of Nova Scotia being closed down during the coming winter as the result of trade conditions and the determination of the miners to oppose any reduction in the rate of wages at present ruling. As he said, the most urgent questions for consideration, in the coming wage negotiations with the United Mine Workers, is not the rate of wages, but whether they can be paid at all, "and most earnest joint consultation and endeavor will be required, if severe and protracted unemployment at the collieries in Nova Scotia is to be averted."

Mr. Wolvin added that "the same wages as during the war, plus two heavy increases since the armistice, are being paid to the workers of the Dominion Coal Company and other coal companies in Nova Scotia. That fact must be faced in the wage negotiations. These high wages are being paid in a period of unparalled trade depression. The price of coal has declined along with that of other commodities, but to a smaller extent, and no action of the employers of mine-workers can be taken that will enable coal to stand out singly against a world-wide decrease in commodity prices arising from world-wide causes. That course was attempted in Britain and most signally failed."

It may not be easy for the rank-and-file of the miners to realize that, while last year saw great, and almost unparalled, prosperity in the coal trade, high selling prices and high wages occurring together, the inevitable time of depression is upon us now. The depression in the coal trade of the world, and in the allied steel trades, too, is the most acute known to modern times. But although the rank-and-file of the miners may not realize these facts, or their import, they must be well within the knowledge of their leaders. And the latter, if, in any sense, worthy of their position, must further be aware that, in the very nature of things, a period of smaller earnings must necessarily also be one of lower wages. On these leaders, accordingly, there devolves a very heavy responsibility. We know that it is no easy task, and we are very sure that it cannot be other than an ungrateful one, for them to press on the miners the necessity of accepting wage reductions. But it is a task from which there is no escape if they are to be faithful to one of the prime and primary obligations of their position of leadership —the obligation to tell the workers the truth, even when that truth is hard.

It is not merely foolish, but it is absolutely futile to attempt, in this period of almost unexampled depression, to maintain wages at a standard which, in the circumstances of today, the coal industry simply cannot pay, except at a loss which it is impossible for it to contemplate. When coal profits were high, wages in the coal mines were high also—and rightly so. Now the lean times are upon us, the workers in the mines must accept reduced wages, if the industry is to be kept in being. Had labor leaders in other industries

advised the adoption of such a course, unemployment, with all its concomitant evils, would be far less widespread in Canada that it is today. It is devoutly to be hoped that the leaders of the coal miners may show themselves inspired by wiser counsels, and, we may add, a higher patriotism.

We trust, too, that they will show themselves to be thus actuated "while yet there is time." But we confess that hitherto there are little signs of such eminently desirable attitude on their part. Mr. J. B. McLachlan, secretary of the United Mine Workers of America, District 26, is on record as having stated that that organization would resist any wage cut. And, after Mr. Wolvin had given out the interview from which we have quoted Mr. Robert Baxter, District president, reaffirmed that statement, and claimed that Mr. Wolvin had been misled by stories in the press to the effect that miners would ask increases when the Montreal agreement ran out. He asserted that the men would ask for no increases, but would resist wage reductions.

Our comment on this, for the reason we have given above, is that it is not good enough—not by a very long way. And if declarations of the kind just mentioned are to be regarded as the miners' last word on the question of wage-reduction, then, once again, Labor's worst friends are likely to be those of its own household.

AN IMPROVEMENT IN ORDERS.

As we observed last month, the condition in which the steel industry in this country has found itself for the last year is such that any indication of a turn in the tide, in the direction of increased activity, is doubly welcome now. In these circumstances, there is some relative satisfaction to be found in the fact that within the last two or three weeks a quite well-defined improvement in the steel situation has taken place. A fair amount of business has been placed in structural. Quite a fair tonnage was released, and some new business placed. The aggregate of orders recently booked booked compares very favorably with the record of very many previous weeks. This is accounted for by the fact that the firmer market undertone has brought purchasers to the realization that price easing is not to be expected, and that there is no advantage to be gained in postponing orders. Some automobile manufacturers have placed business recently, and there has been a fair assortment of miscellaneous buying.

Announcement was recently made of the placing of a 32,000 ton order for rails with Algoma Steel Corporation by Canadian Pacific Railway. This is in addition to an order for 25,000 placed by the C. P. R. a few weeks ago. The lower Pittsburg price will affect the Canadian situation considerably. The reduction announced from the American steel centre amounts to $7 a ton.

Negotiations have been in progress for C. N. R rail contracts. From one source it was announced that 20,000 tons was sought from the Sydney mills. It was stated, later, that this business has not actually been placed, but there are prospects of a favorable announcement in the near future. A Sydney despatch says that the C. N. R. is negotiating for 75,000 tons of rails, and that there are hopes of getting the entire amount rolled in Nova Scotia.

The depression in the iron and steel industry is, of course, part and parcel of the world-wide industrial depression consequent on the war, though accentuated, in the case of this particular industry, by special circumstances, to the force of which we have previously drawn attention. In Great Britain, the general industrial situation is worse than has been known in that country within living memory—worse than it was in 1908 and 1909, when a crisis of trade stagnation and unemployment, with much consequent distress and social unrest, was reached. The year 1920 was a good year, in the iron and steel industry, as in most other industries, in Great Britain, while the post-war false trade boom lasted. But now the iron and steel industry there is suffering acutely. Engineering and ship-building are the worst sufferers, the unemployed in this branch, according to recent trade union figures, numbering about 133,000, or something like twenty-six per cent, of the workers engaged in engineering and ship-building. Further, something like twenty per cent. of the men normally engaged in the metal trades are today among the unemployed.

In the United States, on the side of operations, recent developments have been somewhat more favorable. In the Pittsburg district, steel plants were recently reported to be averaging about forty per cent. At Chicago, the largest producer came up to forty-four per cent, a couple of weeks ago. Two blast furnaces were blown in last month by an independent producer at Pittsburg, another went in at Youngstown, two at Buffalo, and one in Eastern New York. In respect to prices, the situation is reported to show little change.

RESEARCH AND ITS APPLICATION TO INDUSTRY.

In addressing the Western meeting of the Canadian Institute of Mining and Metallurgy in Edmonton some little while back, Dr. H. M. Tory, President of the University of Alberta, made reference to the fact that many of the important discoveries in natural science have been made by workers who considered only in a minor way, if at all, the commercial value of the results of their research.

It is well known that the most thorough investigations are carried on by men who are chiefly interested in science because of their desire to know. It does not necessarily follow, however, that research that is undertaken regardless of commercial results is more

praiseworthy than research carried on with a definite commercial object in view. Nor does it follow that men should be urged to ignore the commercial aspect of research. It is true that many men have failed to profit from the results of their research, and it is likely that many others will have to find their reward in the knowledge of the fact that they have helped in unraveling another secret of nature. Halos for research are cheap in this world, and there are some people who incline to the opinion that a liberal stock of halos is kept on hand by those who turn to their own profit the results obtained by researchers.

We incline to the view that the application of science is quite as important as the truths unearthed by study. In fairness to the researcher, it must be said that he makes gratuitous contributions to his fellows; but he who applies the discovery may make just as important a contribution, and he must also see to it that the commercial results are worth while. Our thanks are due to those who discover truths, but no less are they due to those who demonstrate how knowledge of those truths can be made to serve us profitably.

In claiming that the application of science to industry is quite as important to our welfare as the discovery of nature's truths. we do not wish to detract from the praise that is due research workers who regard the commercial value of their work as of little moment. We wish, rather, to point out that their researches will be of greater credit to them if they do not entirely lose sight of the real object of research—not the search for truth alone, but the search for truth for the benefit of man. It is true that all truths are useful; but it is also true that their usefulness has sometimes remained hidden for days and years, because the researcher had the fault for which there is a tendency in some quarters to praise him—lack of a developed commercial sense.

Dr. Tory states that the primary motive behind research is not commercial, but is "the spirit of man demanding knowledge and going out to find it." He claims that the "best intellects" have never endeavored to make money out of their discoveries. Now there can be little doubt that the researcher, when in the midst of his work, is most likely to get results if he concentrates his attention on his problem. We do not agree, however, that the intellect of the researcher is degraded if he, having made a discovery, endeavors to make useful application of that discovery. Moreover, the ability of the researcher to work is not lessened by his having an idea, when tackling a problem, of the possible commercial value of the solution of the problem. We do not wish to deprecate the value of the investigations that are carried on with the sole object of gaining information; but we are convinced that such researches are not more laudable than researches carried on with a view to gaining information for a definite purpose. There can be no doubt that many discoveries have been made by workers who did not appreciate the value of their discovery, and who worked simply with a desire to learn the facts. They deserve much praise for their contributions to knowledge; but it is as well to remember that if others had not turned their discoveries to the service of mankind there would seldom be occasion to remember the discoverer. All research is valuable, and those who work solely with the view to gain knowledge will always be honored. All the praise that Dr. Tory gives such workers is due them. We, nevertheless, incline to the view that the application of science to industry is quite as important as the unveiling of nature's secrets. Further, we believe that the desired closer contact between colleges and industry will be brought about by mutual understanding of the work of both parties. Those who wish industry to be more sympathetic with the views of the researcher, will do well to rid themselves of the idea that science is degraded when it is turned to service.

In this connection we may refer to the proposed establishment of bureaus of industrial research. To us it seems that such bureaus must, sooner or later, be established in this country. In our opinion, the value of such bureaus will be determined very largely by the endeavor made to learn facts with definite objects in view. The researcher will inevitably follow many byways in seeking his goal and he may well be allowed to spend too much time on these byways and should be reminded that there is a known value to the goal he started for. If the researcher has no other interest than to explore, he is not likely to reach the goal. He may, in his explorations, make valuable discoveries, and the value of these will not be lessened by the fact that they are likely to help him in reaching his goal when he returns to the main object of his search. But aimless wandering with no advance towards a definite object is not the type of research that industry wants. Those who are in charge of bureaus of research must be familiar with the problems of industry and point the way, so that the work of the researcher will be along lines that are likely to lead to results that are commercially valuable. If the "best intellects" cannot work along these lines, industry will have to use ordinary mortals in its research bureaus as it does in its other departments.

SHIPBUILDING IN CANADA.

In the course of the election campaign, the Government is coming in for a good deal of criticism, at the hands of the leader of the Liberal party, by reason of its record in ship construction. Most of the ships that it built were, it is aversed, completed after the

signing of the Armistice, and it is contended that they were unnecessary, on the ground that the situation so changed after that date that ships could have been picked up almost anywhere at a considerably less cost to the people of Canada. It is, further, said that the ships built are now looking high and low for cargoes.

Whatever may be said for or against the Government's ship-building program in the past, it is a fact which does not brook denial that the condition of the ship-building industry in Canada today is a lamentably quiet one. Many yards are entirely without work, and the only fresh tonnage being laid down is small and insignificant. This has been the case for many months. The repair shops, also, are finding trade exceedingly dull. Nor do there seem much signs of any improvement in the near future.

The ship-building industry in the Dominion is divided into three districts—Eastern Canada (from the Atlantic Seaboard to Montreal), the Great Lakes, and the Pacific Coast. In the first and last, mainly ocean-going ships of varying tonnages are constructed, while the yards on the Great Lakes more or less confine themselves to freighters, particularly grain carriers, though the builders, there have successfully constructed certain ocean going vessels. During 1920 the two largest ocean frighters ever built at the head of the Great Lakes were completed and delivered. They totalled 9,200 dead-weight tons. The Great Lake ship-builders have a considerable handicap in constructing large ocean-going ships, for it is not possible for these vessels to reach the sea intact, and it is therefore necessary for them to be cut at a Lake Erie port and taken through the Welland and St. Lawrence Canals to Montreal in two sections and re-joined there.

It may conceivably be, as we have intimated before today, that, in the direction of ship-building, too much was attempted all at once, and attempted too soon.. But, nevertheless, the progress that Canadians have made in this matter has been very remarkable. It speaks well for Canadian industry, too, that, every year, our ship-builders are finding that they can obtain a greater percentage of their total requirements in this country. In the case of an 1,800 freighter, recently built for the Canadian Government Merchant Marine, for example, practically everything in the ship was made or produced in Canada. We believe that, as a consequence of our national spirit, and in response to the requirements of our commerce of the future—at the moment we hesitate, in view of the proposals, as regards navies, made at the Limitation of Armament Conference, to say much about considerations of national defence—the ship-building industry must necessarily ere very long, bulk big among the staple industries of the country.

REPORTED MERGER PLAN.

Current revival in the daily press of the reports that negotiations are under way for the merger of prominent independent steel companies are based, says the "Iron Trade Review", on more substantial grounds, it is understood, than those which have been circulated at various times in recent years. The proposed merger, however, still is in a very preliminary state of consummation and while the present outlook for its being carried through eventually, is said to be more favorable than had characterized the previous efforts along this line, it is learned that the final result is not likely to be reached for two or three months. It is pointed out that a tremendous amount of detail work is involved in compiling the data with respect to each individual company which would form the basis for the negotiations and merger. This includes the assembling of such facts necessary to determine current values upon which would be based the proportionate rights of stockholders in the proposed combination. To this end, appraisals of some of the companies suggested for the merger are being made. The name of the leading firm of New York bankers has been mentioned as the one which will handle the financial details of the consolidation should it be carried through.

Three leading independent companies have been definitely stated as figuring in the merger plan. These are the Youngstown Sheet & Tube Co., Republic Iron & Steel Co., and the Midvale Steel & Ordnance Co. Other companies, the names of which have been associated with the plan are the Steel & Tube Co. of America, the Lackawanna Steel Co., and the Brier Hill Steel Co. Officials of the Jones & Laughlin Steel Co. and the Bethlehem Steel Co. have denied they are involved in the present negotiation. The name of the Inland Steel Co. also has appeared in current reports, but it is questioned in well informed circles whether it would become a party to the plan.

The combined present capitalization of bonds and stocks of the six companies reported to be under consideration in the proposed merger is approximately $300,000,000.

LOWER RAIL PRICES.

A matter of paramount interest to the steel industry developed recently in a reduction in the price of steel rails by the United States Steel Corporation, which announced that its subsidiary companies would lower the price of open hearth rails to $40 per ton. Pittsburg, which means a rather sharp cut of $7 per ton. Nothing was said about the Bessemer product, but it is presumed that the old differential of $2 per ton will be maintained, which will bring the prices now current by the leading interest down to $38 and $40. respectively, for Bessemer and open hearth, as against the former quotations maintained since early last December of $45 and $47, respectively. The reduction, it was announced, had been made without reference to the cost of production, which, it was hoped, would be rectified by lower freight rates and increased business. How far the independents will go in the matter of meeting the competition of the leading producer will be watched with interest. It may be presumed that the new price at least will become general. The railroads have been buying a few rails urgently needed, but the 1922 requirements had not been placed pending a price readjustment.

Heat Treatment of Nickel Gun Steel

The Research Department, Woolwich, have issued a report (R.D. Deport No. 49) supplementary to R.D. Report No. 9, which had special reference to the effect of the time of tempering, and of different tempering temperatures.

The present report deals chiefly with:—(1) Correlation of the microstructure with the heat treatment received. (2) The effect of different rates of cooling through the critical range, of high tempering temperatures and of rate of cooling from the tempering temperature, on the mechanical properties, including results of notched bar impact tests. The following shows the chemical analyses of the steels used:—

	A. Per cent.	B. Per cent.	C. Per cent.
Carbon	0.350	0.350	0.380
Silicon	0.150	0.110	0.080
Manganese	0.650	0.640	0.630
Sulphur	0.025	0.031	0.023
Phosphorus	0.025	0.025	0.027
Nickel	3.760	3.650	3.450
Chromium	0.020	0.070	0.020

Specimens of steel A (3 to 4½ in. long by about 0.6 in. square) cut transversely from the forging and drilled at one end to take a thermocouple, were heat-treated in an electric furnace. They were subsequently machined to Izod test pieces with two or three notches of the standard form (2 mm. deep, 45 deg. V notches with root radius of 0.25 mm.) on the side nearest the axis of the forging. The Brinell hardness and Izod impact figure were determined and the microstructure examined. It appears from the results that the following limits of temperature may safely be taken as applying to nickel gun steels, containing from 0.3 to 0.4 per cent. of carbon with 0.5 to 0.8 per cent. of manganese.

Nickel per cent.	3.0 to 3.5	3.g to 4.0.
Ac_1 begins at temperature not below	Deg. C. 680	Deg. C. 670
Ac_1 maximum occurs at	695 to 703	690 to 698
Ar_3 ends at a temperature not above	760	750
Ar_3 begins at a temperature not above	680	650
Ar_1 maximum occurs between	610 and 580	600 and 570

Some features of interest in these results are:—(1) The hardening and improvement of the impact figure by the suppression of the separation of ferrite by rapid cooling through the critical range, and the almost complete elimination of these advantages by reheating to Ac_1. (2) The improvement in impact figure of the unhardened steel, without appreciable change in hardness, brought about by reheating to a temperature a little above the critical range and cooling, thus refining the grain size. (3) The improvement of the quality of the air-cooled and slowly cooled steel by reheating to above the critical range and quenching in oil, followed by tempering. This improvement is due to diminution of the amount of ferrite and substitution of sorbite for pearlite.

Samples of steels B and C (about 1 in. by 2 in. by 6 in. long) cut transversely from the forging were heat-treated. The results illustrate: (1) The simultaneous reduction of elastic limit, yield point, yield ratio and impact figure produced by relatively slow cooling through the critical range. (2) The bad effect of a high tempering temperature on the elastic limit and yield point of the steel.

The behaviour of nickel gun steel in these respects is identical with that of carbon gun steel (R.D. Report No. 48) and the accompanying microstructural changes are similar. Details in which it differs from carbon steels are:—(1) That a high tempering temperature does not injuriously affect the impact figure in addition to its effect on the yield point and elastic limit. (2) That a very high oil-hardening temperature does less harm to the properties of the steel, suggesting that the upper limit of the safe hardening temperature is in practice determined by providing efficient cooling and avoiding the danger of cracking. (3) That the rate of cooling from the tempering temperature may have a considerable influence on the impact figure, though the results of tensile tests are unaffected.

Temper Brittleness of Nickel Steels.

Temper brittleness is the term applied to a condition induced in certain steels (chiefly nickel-chromium steels) by slow cooling from the tempering temperature, and revealed by a low absorption of energy in the single-blow notched bar impact test.

Slow cooling from the tempering temperature of certain oil-hardened and tempered nickel steels results in a reduction of impact figure. The conditions for producing or avoiding brittleness (as far as they are known) are the same as for nickel-chromium steels, and there is no reason to suppose that the cause of the brittleness is different. Most acid open-hearth nickel gun steels contain some chromium (say, 0.01 to 0.1 per cent.) but the total amount of chromium present does not determine the susceptibility to temper brittleness.

As in the case of nickel-chromium steels, the susceptibility to brittleness (as measured by the ratio of the impact figures obtained by quick and slow cooling respectively from the tempering temperature) is increased by the suppression of free ferrite in the hardened steel and by raising the oil-hardening temperature, and is diminished by raising the temperature of subsequent tempering. No nickel steels have yet been met with which to develop brittleness with anything like the same readiness as the average nickel-chromium acid open-hearth gun steel. A moderately slow rate of cooling, which might reduce the impact figure of a nickel-chromium steel to a very low value, would probably have little effect on the impact figure of a nickel steel. Hence, whilst cooling in the furnace might induce dangerous brittleness in some nickel gun steels, and should be avoided in every case, air cooling is probably sufficiently rapid to prevent the embrittling action from taking place.

Application of the Results.

The remark in R.D. Report No. 48 on the annealing, normalizing, hardening and tempering of carbon gun steel apply with certain modifications equally to nickel gun steel. A similar but modified constitutional diagram holds, but Ar_3 and Ar_1 occur at a much lower temperature than in carbon steel, hence for a given rate of cooling the separation of ferrite will occur less readily, and for formation of pearlite will be slower. Thus nickel steel will harden more readily than carbon steel, though it is quite as sensitive to variations in the rate of cooling through the critical range. The best results cannot be obtained with nickel steel unless separation

of ferrite is largely suppressed in hardening, and if, by reason of the mass of the forging, a suitably quick rate of cooling cannot be obtained, a steel of different composition should be used.

The critical temperatures of greatest importance in heat treatment, Ac_1 and Ac_3 are lowered. The Ac_1 point is lowered by nearly 40 deg. C. with 3.5 per cent. of nickel, and a tempering temperature correspondingly lower than the maximum permissible with carbon steel should be employed. It is advisable not to exceed 655 deg. C. In the same steel the Ac_3 point is lowered by about 60 deg. C., and a lower temperature for hardening is permissible. On the other hand, the safe range of oil-hardening temperatures, resulting in no deterioration of properties, is wider than for carbon steel, so that there is no danger in exceeding Ac_3 by a good margin. A minimum temperature of 820 deg. is recommended. The rate of cooling after tempering frequently has a greater effect than on carbon steel; it should be not slower than air cooling.

BRIDGE OVER DETROIT RIVER.

Good progress, says the Toronto Mail and Empire, is being made with the scheme to construct a bridge over the Detroit River between the city of that name and Windsor. The detailed plans have been made for the exact loads the bridge is to carry and the sizes and weights of all parts of the structure have been accurately determined. The total weight of the bridge and approaches is 107,000 tons, and the span, as fixed, is 1,803 feet over the river, which will give it an advantage of three feet over what has hitherto been the longest span in the world, that of the great 1,800 cantilever span at Quebec. The greatest bridge in the world is that across the Firth of Forth, in Scotland, which has two cantilever spans of 1,710 feet each.

The construction of the Detroit River bridge will occupy about four years, but it is expected that highway traffic can be provided for in less time by placing four of the eight cables at first, and only that portion of the steel work necessary for carrying the highway deck. This highway deck will be 97 feet wide, with two trolley tracks, two sidewalks and two roadways that will carry six lanes of traffic, or a capacity of 30,000,000 automobiles per year. Later four additional cables will be added, as well as the balance of the steel work, without interfering with the traffic of automobiles, auto-trucks and street cars over the upper or highway deck. This lower deck will have four railway tracks to carry electrically-operated trains, and a twenty feet space for public utilities, such as wires and pipes. The towers of the bridge will rise to a height of 380 feet above the water, and will be constructed in nickel-steel. They will have a massive architectural effect, similar to the Woolworth Building, in New York City.

An able Board of Engineers has been created to supervise the construction of the bridge. The chief engineer and chairman of the board is Mr. Charles Evan Fowler, member of the American Society of Civil Engineers, and member of the Engineering Institute of Canada. Mr. Fowler has had charge of the construction of many of the most important bridges in the United States and Alaska. With him will be associated Messrs. George H. Pegram and William H. Burr, representative American engineers, and Co. C. N. Mousarrat and Mr. C. R. Young, equally representative of the profession in Canada. Col. Mousarrat, who was the principal engineer in charge of the Quebec bridge while it was under way, is at present consulting bridge engineer for the Canadian National Railways, and Mr. Young, one of the leading educators in his line, is now professor of structural engineering at the University of Toronto. Both the Canadian members of the board are regarded as amongst the highest authorities on bridge construction in the Dominion.

U.S. OCTOBER OUTFIT OF IRON.

Data collected by "Iron Age" covering the output of blast furnaces in October show a decided improvement over the production in September. The gain per day of 7155 tons compares with gains in August and September of 2070 tons and 2891 tons per day respectively. For the first time in over four months the total output has passed the one million mark.

The production of coke and anthracite furnaces for the 31 days in October amounted to 1,240,162 gross tons or 40,005 tons per day as compared with 985,529 tons or 32,850 tons per day in September, a 30-day month. The October output is the fourth largest for the year, exceeding all the months except those of the first quarter.

The total number of furnaces in blast on Nov. 1 was 96 as compared with 82 on Oct. 1, with 70 on Sept. 1 and 69 on Aug. 1, the low point in the recent decline. On Jan. 1 this year there were 201 furnaces in blast. Seventeen furnaces were blown in and only 3 blown out or banked during October, a net gain of 14, which compares with a gain of 12 furnaces in September.

A computation of the capacity in blast Nov. 1 is difficult in view of the compilation of the production figures on the first day of the month. It is roughly estimated that the 96 furnaces in blast Nov. 1 were then producing about 43,500 tons per day.

The October output of manganese-alloy was only 3902 tons, all of it ferromanganese, no spiegeleisen hav- been made in several months.

IRISH DEPOSITS OF GYPSUM.

Fives bores sunk at Knocknacran, about two miles from Carrickmacross, in County Monaghan, Ireland, early in 1921, proved the existence of a large deposit of gypsum, according to the U.S. Consul F. T. F. Dumont in "Commerce Reports." Bores put down at Lisaboe, County Meath, in prospecting for coal or other minerals disclosed a body of gypsum estimated by an expert of the Department of Geology at 1,000,000 tons. The Farney Development Co., Ltd., is said to have secured the mineral rights over this property and to be building a factory capable of producing twenty-five tons per day of plaster of paris. About 1,000 tons of high-grade gypsum has been quarried and is ready for manufacturing. Some large blocks of beautifully colored Irish alabaster have also been secured, and it is reported that the entire output of this product will be taken by the Irish Marble Co., of Kilkenny, for disposal among its customers.

The British-American Fuel and Metals Limited, McKinnon Building, Toronto, Ont., are representing in Canada, Sixteen mines of the Pittsburgh and Youghiogheny districts, also the West Penn By-Products Company.

This Company is British controlled and its directors consist of some of the best known steel manufacturers and coal producers on this Continent. The General-Manager, Major S. Snell, late Royal Engineers, informs us that his Company is selling fuels in Canada upon a technical basis, and they are prepared to supply consumers with a fuel which will suit their purposes so as to secure the greatest economy and efficiency.

The Manufacture of Silica Brick

A. W. McMaster, A.M.E.I.C.

Owing to the increase in cost of silica brick and the difficulties in obtaining them, in sufficient quantities due to war conditions, it was decided in the Spring of 1917 to look into the practicability of making silica brick locally.

Field work carried on that summer indicated that three properties in Cape Breton showed promise of containing a sufficient tonnage of quartzite or silica rock to make them possible sources of raw material, and further investigation proved that each of these deposits, Skye Mountain, Aberdeen and George's River, contained stone suitable for refractory purposes.

It might be well here to give a definition of a suitable quartzite for refractory purposes. Three properties of the quartzite should be considered: —

No. 1. — Mechanical strength,

No. 2. — Melting point,

No. 3. — Behaviour on burning.

Experience has shown that to produce a physically strong brick, the stone must be hard, dense and give splintery angular fragments of heterogeneous size on crushing, one that crushes down to rounder grains cannot be used. The strength of a brick and its melting point are conditional by the analysis of the rock. The silica content may vary from 96 to 98 per cent, if less silica is present, the fusion point is lowered. Attempts to use pure quartzite of 99 per cent silica (dioxide SiO_2) have not met with success. The presence of alumina (Al_2O_3) or ferric oxide (Fe_2O_3) is necessary to form a bond. Their combined percentage is usually 1.75 per cent and should not exceed 2.5 per cent. The amount of alkalies should be less than .5 per cent.

American authorities give typical analyses of suitable quartzites, which are compared with average analyses of rock from the localities previously mentioned.

Comparative Analyses. — Quartzites.

It will be noted that they all come within the requirements as specified for refractory purposes. The silica contents being respectively, 97.27, 96.87, 97.41 per cent, which is between 96 to 98 per cent. The combined alumina and iron oxide being respectively 2.01, 2.05, 1.80 per cent, which is between the limits of 1.75 and 2.5 per cent. Each of these quartzites break on crushing into splintery fragments. George's River stone giving the most perfect analysis and made the best brick as tests referred to later show.

Our experimental plant was located in the South end of one of our open hearth brick sheds, on account of there being an 8'-6" Clearfield dry pan installed there, for grinding brick bats. This was converted into a wet pan by replacing the slotted bottom plates with solid cast iron ones.

The necessary flooring, runaway, bin and platform were built about the grinder and the following equipment provided: —

2 — ½ barrels calibrated to gallons.
1 — moulding table with turnover device, necessary moulds and tools.
1 — stripping bench with sand box.
2 — rack cars.
150 — sheet iron trays.
1 — dryer house, capacity for two rack cars.
1 — down craft kiln—size about 10' x 17' x 9'-6" inside. Capacity — 7500 — 9" eq.
Necessary track 2 ft. gauge, from moulding table through dryer house to kiln with turntable and spur to allow the return of empty car to moulding bench.

Both ½ barrels were fitted with 1¼" piping and valve. The one used for slacking the burnt lime to make the milk of lime had a wire screen over the end of the pipe — the other ½ barrel contained water to add to mixture if required, both were blocked up on platform to allow contents to feed into the wet pan by gravity. Silica brick expands on burning, so the moulds are made smaller than the desired size of brick, allowing 3-8" to 7-16" per foot for expansion.

Three lots of 3½ tons of rock, sufficient to make 1,000 bricks, were procured from each of the localities mentioned. Any stone, requiring to be reduced in size to pass through a 2" ring, was broken with a stone hammer. We adopted a standard batch sufficient to make 100 bricks consisting of: —

700 lbs. of rock,
14 lbs. of burnt lime (i.e. 2 p. c. by weight),
12-14 gallons water.

The rock was weighed carefully and placed in the bin at the top of the runway. The lime also was carefully weighed and slacked in 60 per cent by weight of water — to which was added 11 or 13 gallons of water, making the milk of lime. It is preferable to use warm water to slack the lime.

When everything was in readiness the grinder was started and the gate of bin opened, feeding the stone into the grinder gradually. The rock was ground from 15 to 18 minutes, during this time the milk of lime was added and then more water if necessary to bring the mixture to the proper consistency. Then the mud was shovelled out of the pan in motion on to the moulding table.

Our crew consisted of —

1 — foreman,
1 — moulder,
1 — moulder's helper,
1 — material man.

Constituent	Medina Pennsylvania	Baraboo	Alabama	Skye	Aberdeen	George's River
Silica, SiO_2	97.80	97.15	97.70	97.27	96.87	97.41
Alumina, Al_2O_3	.90	1.00	.96	1.42	1.46	1.07
Iron Oxide, Fe_2O_3	.85	1.05	.80	.59	.59	.73
Lime, CaO	.10	.10	.05	.11	.07	.11
Magnesia, MgO	.15	.25	.30	.29	.34	Tr.
Alkalies	.40	.10	.31			
Loss Ignition				.44	.59	.44
	100.20	99.65	100.12	100.12	99.92	99.76

The sanded moulds being in place on the [illegible] device on the mould table the mud is picked up by hand thrown into and heaped over the mould and pounded with a flat mallet then cut off level with the mould and smoothed over with a slicker or two handled trowel. The helper then places a tray bottom up on the mould, turns them over and places them on the stripping bench — immediately after, placing a sanded mould before the moulder for him to carry on. He then strips the green brick by placing a stripper made of wooden blocks attached to a small board over the filled spaces and steadily pulls up the mould, using the stripper as a guide. Thus leaving the green brick on the tray, which is placed on the rack car. Lead figures were fastened on the underside of the stripper blocks to mark on the brick when stripping, the number to indicate locality the quartzite or silica rock came from. When the car was filled (288 brick) it was placed in the dryer house. The moulding of sufficient brick to fill the two rack cars (576 brick) was considered a day's work, being equal to the capacity of the dryer. It took 12-15 hours to dry the brick bone-dry at a temperature of 250-270 degrees Fahrenheit.

Next day the cars were pushed into the kiln and the bricks stacked on edge, two rows being set in the same order and the next two rows at right angles — and so on — No. 2 quality silica glass sand is sprinkled between the bricks to keep them from adhering to each other at high temperatures. Every six courses a layer of old brick tile was set to bind them together and distribute the weight evenly. When kiln was filled to about 18'' to 24'' from the roof, the doors were bricked in and fires started promptly.

Burning.

The operation of burning takes from 9 to 10 days and is divided into three periods —

(1) Dehydration,
(2) Oxidation,
(3) Vitrification.

The first three days the fires were kept thin, allowing plenty of air to circulate through the kiln to carry off whatever moisture there might be in the brick, the temperature rising to about 300 degrees C to 572 degrres F. In the second period the fires were thickened and draft lessened from 4 mm. to 3 mm. — the temperature rising gradually to about 600 degrees C. or 1,000 degrees F. on the sixth day. In the last period, the fires were heaped up to the top of the doors and draft gradually lessened to 2 mm., the temperature being forced up to 1,490 degrees C. or 2,700 degrees F.

The temperatures were observed by means of Seager cones, set a few courses above the floor in the centre of the kiln, a small tunnel being built from them to a peek hole. The draft was controlled by a differential draft gauge set in the flue on the furnace side of the damper. As soon as cone 31 indicating 1,490 degrees C. of temperature showed signs of bending, all four doors and ash pits were sealed with plates, cut to fit and plastered with clay all around. The kiln remained sealed for 12 hours, allowing the brick to soak. On the 10th or 11th day the plates were removed and several bricks taken from the top of each door. The [illegible] were gradually increased and damper opened, cooling taking about three days. Too rapid cooling will spall the brick and also make them spongy.

Bricks on being taken from the kiln appeared to be well vitrified, strong mechanically and true to size. ample brick were sent to the laboratory for analysis and determination of fusion point, the results of which are shown here, in comparison with the Standard Star silica brick of Harbison-Walker Refractories Company:

We planned to test the bricks under actual service conditions in our open hearth furnaces. This had to be done cautiously so as not to disturb operations — Our first test was made by building a section of the back of the bulkhead flue on one of the furnaces down for repairs. They stood the test well, so then a portion of one of the front piers was built with home-made brick, — this also proved satisfactory.

It was then decided to build the half of the front of three separate furnaces as they came off for repairs with the brick from Skye, Aberdeen and George's River, the results of these tests showed bricks from

Aberdeen quartzite stood up in piers 59 Heats
Skye quartzite stood up in piers .. 65 Heats
Geo. River quartzite stood up in piers 70 Heats

The average life of a front wall for the previous six months to our tests was 61 Heats.

The cumulation of this work, which proved that suitable brick could be manufactured from local silica rock, has been the opening of a quarry at Leitches Creek, referred to before as George's River, and the erection of a plant capable of manufacturing 10,000 9'' eq. per day of 10 hours.

Concurrently with silica brick experiments we carried on experiments in making clay brick with such gratifying results that it led to the establishment of a plant devoted to the manufacture of clay runner brick, using for bottom pouring the ingots for the plate mill. This plant has been in operation for a year and recently has also taken up the manufacture of ladle brick, which are superior to brick previously purchased, standing up to 20 to 22 heats in the ladle. This plant has a capacity of 10,000 9'' eq. We have made about 200,000 to 250,000 of these ladle brick from

60% pit stone from No. 16 mine.
25% grog.
15% Mackay clay.

The runner brick plant has made up to 7,000 9'' eq. per day. These brick being made of a mixture of

25% Mackay clay.
75% grog.

Machinery is being installed to manufacture runner brick and the output will be considerably larger when this is put into operation.

The cost of a silica brick plant is about $250,000 and the quarry $50,000, a total sum of $300,000. The cost of runner brick and ladle brick being about $75,000.

Analyses of Silica Brick.

	Silica	Alumina	Ir. Ox.	CaO	Mag.	Loss Ignition	Fusion
Aberdeen Brick	93.15-93.90	2.10-2.22	1.71-1.48	3.02-2.10	Trace	[illegible]	1710 deg. C. or 3110 deg. F.
Skye Mt. Brick	94.24-94.72	1.31-2.16	1.58-1.18	2.57-2.04	Trace	.30-Nil	1750 deg. C. or 3182 deg. F.
George's River Brick	95.08	1.84	1.23	2.10	Trace	.10	1750 deg. C. or 3182 deg. F.
Star (Harbinson-Walker)	96.25	.88	.79	1.80	.14	.39	

The International Nickel Co. of Canada Ltd.

An Outstanding Concern Which, With its Mining Smelting and Refining Division, Supplies, Among Other Products Nickel, a Metal of Which Canada Possesses Almost a Monopoly.

By A. R. R. JONES.

The International Nickel Company of Canada, Ltd., supplies, among other products a refined metal—nickel—of which Canada possesses almost a monopoly. It has three main divisions. There is its mining and smelting division; its refining division, and its sales department. The last-named is situated in Toronto, in the Harbor Commission Building, where the head offices of the Company are also located. In fact, the Company occupies the whole of the fourth floor of that large building, and exceptionally handsome and spacious its offices are. The present method of distribution by the Company is, at present, entirely through this sales department. It handles nickel and nickel products, including Monel Metal, in the forms of sheets and rods and shot and nickel salts.

The officers of the International Nickel Company of Canada, Ltd., are as follows: Mr. Arthur D. Miles, president; Mr. John Agnew, vice-president and general manager; Mr. George E. Silvester, assistant to the president; Mr. Britton Osler, secretary; Mr. F. P. Bernhard, auditor; Mr. C. A. Richardson, sales manager; Mr. J. C. Nicholls, general superintendent at Copper Cliff; and Mr. John More, general manager at Port Colborne. When the Company is operating at its full strength, the employees in the mining and smelting division at Copper Cliff number around 3,500 and those in the refinery at Port Colborne about 750.

Monel Metal and Its Uses.

The outlook for the nickel business at present depends, perforce, very largely on the resumption of activity in the steel industry. It is, of course, common knowledge that, for nearly a year now, the steel industry in this country has been in a very listless condition. Largely this depression is attributable to the fact that transportation charges are nearly double, fuel costs more than double, and building trades labor costs double the charges under those respective heads before the war. Happily, there are some indications that the steel industry is about to brisk up.

Nickel steel is much used in automobile construction and also in marine machinery on account of the large reduction of weight in which its use results, as compared with the use of steel.

But one feature in connection with the Company's business, which makes for brighter prospects at the moment, is the business that it does in Monel Metal. For this is not used in conjunction with steel but by itself. It constitutes, in fact, one of the most important uses of nickel. There are very many ways in which it can be used to great advantage. For one thing, it can, in many cases, replace steel and bronzes. Indeed, it compares favorably in price with the higher grades of bronzes, and, though its cost may be higher than that of some grades, yet it possesses certain properties, such as that of non-corrodibility, that they lack.

Among the many uses to which Monel Metal is put may be mentioned the following; for parts of power plants; of gas and oil engines; of mining equipment; of dairy equipment; for storage battery casings; for meat slicing machines; for golf club heads; for parts of submarine torpedo and ordnance; for valve stems for high-pressure fire service; for general equipment, such

Cupola Furnace Building at the Refinery at Port Colborne, Ont.

as that of packing houses, which comes in contact with salt and brine; for refrigerating machinery and refrigerators; for laundry machine parts; and so forth. In fact its various uses are almost endless, and these the Company is steadily developing.

Early Days of Smelting Nickel.

The Company's mining and smelting division is, as has been stated above, at Copper Cliff in the Sudbury district of Ontario. In fact, until the advent of the Monel Company, which, in 1901, began to produce nickel in 1901, the Canadian Copper Company, which is the predecessor in title (so to speak) of the International Nickel Company of Canada, Ltd., and which is now amalgamated with the latter concern, was (with the exception of a few sporadic operations) the sole smelter of ores in the Sudbury district.

Thus the history of the nickel industry in Canada dates from the incorporation. in January 1886, of the Canadian Copper Company, now The International Nickel Company of Canada, Limited, by S. J. Ritchie of Akron, Ohio, and some business associates from Cleveland, Ohio. The original holdings were acquired by Mr. Ritchie in 1885 from prospectors who had been prompted in their search by exposure of ore in a rock cut at Murray Mine near Sudbury during the construction of the Canadian Pacific Railway then recently completed through that district. The early discoveries were taken up for copper only, the presence of nickel not being suspected, hence the inappropriate name—

The Company's Smelter at Copper Cliff, Ont.

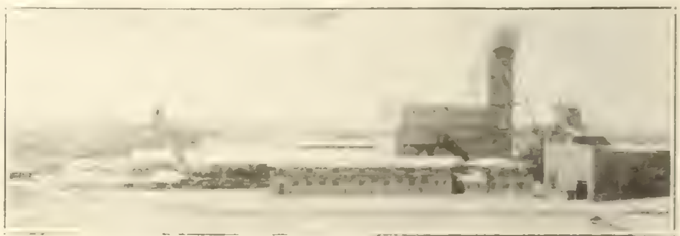
"The Canadian Copper Company." In 1888, after a good deal of preliminary investigation, a smelting plant with one small blast furnace was designed and built at Copper Cliff by Dr. E. D. Peters who had been engaged as Manager. Dr. Peters had stated that a furnace to smelt 100 tons per day would be "enormous and unprecedented," and when asked later if he thought the smelter could be enlarged to treat 300 to 500 tons per day, said it might be done, but such large figures were very bewildering, as no plant in America was treating so much. It required comparatively little nickel at that time to swamp the entire world's markets, consumption being only about 1000 tons annually, and it was only with the development of nickel-steel and its adoption for armour plate by the United States Navy that The Canadian Copper Company began to get on its feet.

The Canadian Copper Company's operations continued to grow in spite of difficulties and disappointments, financial, metallurgical, mechanical and economic. The original (East) Smelter was enlarged from time to time until there were six furnaces, and further expansion on the original site was practically impossible. Then in 1899 the West Smelter was built. This was an up-to-date plant with eight furnaces, but still using the same type of small Herreshoff water-jackets, hand-fed and with hand-pushed matte buggies. Most of the slag had been granulated since 1891.

The Period of Rapid Development.

In the fall of 1891 a Bessemer Converter plant was built, and in 1900; the Ontario Smelting Works at Copper Cliff was put up by the Oxford Copper Company. Various mines were, from time to time, operated, and, in 1901, the construction of what is now known as the Algoma Eastern Railway, from Sudbury to Gertrude Mine, provided an opportunity to develop Creighton Mine, which soon proved to be a very extensive orebody. Then, in 1902, the International Nickel Company of Canada was formed. This combined, with certain other interests, the Canadian Copper Company, operating mines and smelter, and the just mentioned Oxford Company, operating the refinery, but the former Company, as indicated above, retained its name and identity until its amalgamation with the International Nickel Company of Canada, Ltd., in 1918. At this point, a period of rapid development, made possible by an ample supply of capital began.

The first step was the construction of a modern smelting plant on a new site, employing large units with everything possible operated mechanically. The Ontario Smelting Works was superseded by a Bessemer Converter plant adjoining the blast furnaces, using the latest type of acid copper throughout, for example, the use of alternating current for the operation of cranes and converters. This plant was blown in on July 20th. 1904. The first installation consisted of two blast furnaces 50" x 204", and three acid converter stands.



Creighton Mine.

Steam power was used at the smelter until the construction of the High Falls Hydro-Electric Plant, which was put into service in February, 1905, a thirty-mile transmission line having been completed to Copper Cliff, with branches to Creighton Mine and the newly opened Crean Hill Mine. Since that time everything at mines and smelter has been operated electrically, except railway transportation.

The present smelter since it began operations in 1904, has experienced a practically continuous programme of expansion and evolution to provide for increased production requirements and changes and improvements in smelting practice. The two blast furnaces have increased to eight, five of these being of the original length, one a quarter longer, and two a half longer.

The three acid converter stands became ten and then were shortly afterwards replaced by large basic converters of modified Peirce-Smith type, 37 ft. x 10 ft. The first of these was blown in in March, 1911. There are now six in service.

To take care of flue dust and excess ore fines a Reverberatory Plant was built in 1911 with two furnaces, 19 ft. x 112 ft., using pulverized coal for fuel. This was the first reverberatory installation of this kind, and has since been widely copied in copper practice.

The reverberatory plant includes four Wedge me-

chanical roasting furnaces with ball-mills for fine grinding.

The Roast Yards, which at one time formed three angles of a triangle surrounding Copper Cliff, much to the discomfort of the inhabitants, but which later were confined to one location about a mile from the town, and finally moved, in 1916, to a new site about nine miles west of Copper Cliff.

The Refinery at Port Colborne.

The refinery, as has been stated, is at Port Colborne, Ont., on the shore of Lake Erie, about twenty miles west of Buffalo. The site consists of 330 acres and has a frontage of about half a mile on Lake Erie. In all, there are thirty-one buildings of steel and brick construction. The design of the works provided for a complete power plant, a water-supply system, a separate sewerage scheme for storm water and sundry drainage, an electric-conduit distribution system for power and lighting and piping system for steam, oil and compressed air. The various units of the plant are served by both standard gauge and narrow-gauge railroad tracks. Railroad facilities are provided by the Grand Trunk Railway. Special attention has been paid to light, heating and ventilation, and the mechanical handling of material has been brought to a pitch of perfection. The plant was built at a cost of over $5,000,000.

The Company's Refinery at Port Colborne, Ont.

There is a hospital in a detached building. A staff house is provided for the employees, and a club-house for the accommodation of the unmarried men and executive heads. The club-house is admirably equipped for both residence and recreation, and the houses built by the Company are exceedingly attractive.

The Largest Process Building.

The largest process building is 76 feet long and 125 feet wide, and contains most of the heavy machinery and metallurgical equipment, among which are three cupolas, three reverbatory furnaces, two slag furnaces and three converters. Here the matte, received from the smelter at Copper Cliff, undergoes preliminary treatment. This matte, which consists of 55 per cent. nickel and 24 per cent. copper, is smelted with salt, cake, the nickel separated and the copper bessemerized in 84 by 126 inch Allis-Chalmers converters. One fifty-ton, one thirty-five ton, two twenty-ton and two five ton cranes are installed in this building, all of them having been built by the Dominion Bridge Company, Ltd., of Lachine, Que.

Among the other process buildings, are those used for the purposes of leaching and roasting. The leaching is carried out in a building 420 feet long by 90 feet wide. To facilitate the handling of the product between the leaching and roasting departments, these are connected by three overhead bridges. The building in which the roasting furnaces are installed is 380 feet long and 110 feet wide, and it has one clear span of 90 feet in which the ten mechanical and hand-calcining furnaces are installed.

The nickel-refining department is particularly admirable in arrangement and equipment. One part of this building is used for the storage of chemicals, etc., and contains a very perfect system of bins and measuring and weighing devices, for the preparation of furnace charges to go to the nickel-refining furnaces. These are located in the main portion of this building, and are of special design rendered necessary by the high temperature which exists under the operating conditions desirable.

The power plant is of the most approved power-house design. The main power-house boiler room contains for Babcock and Wilcox standard water-tube boilers, each of 4,319 square feet heating surface, set in two batteries. Two Babcock and Wilcox boilers of special design are installed for utilizing the waste heat from the reverbatory furnaces in the nickel refinery. They are built for an output of about 400 boiler-house power each, and are of the very latest design in this phase of engineering.

Turbines, generators and feed-water equipment are all the best word of perfection in their respective categories. The machine shop, so necessary an adjunct to a plant of this kind, is 200 feet long and 175 feet wide, and it also accommodates the forging equipment and a complete electrical repair shop. There are also a very complete carpenter shop and a cooperage.

At full capacity, the yearly production of the Port Colborne refinery consists of about 15,000,000 lbs. of nickel and 8,000,000 lbs. of copper.

COAL PRODUCTION IN U.S.

Production of soft coal in the United States showed a decided improvement during the week ended September 17, and for the first time since early in June, passed the eight-million ton mark. The total output, including lignite, coal coked at the mine, and mine fuel, is estimated at 8,139,000 net tons. In comparison with the week ended September 3, the most recent week of full time production, this was an increase of 533,000 tons, or slightly over 7 per cent. So far as it has gone, the year 1921 is in round numbers 47,000,000 tons behind 1919, 97,000,000 tons behind 1920, and about 126,000,000 tons behind the average of the war years. Compared with the average of all four years, it is 99,000,000 tons behind. In considering the possible effect of this subnormal production it must be remembered that the consumption of bituminous coal varies greatly with the general condition of business. For example, in 1914, a year of industrial depression, domestic consumption was only 409,000,000 tons; in the war year, 1918, when industry was running at a maximum, it was 530,000,000 tons. In 1914 a production of 423,000,000 tons was sufficient to fill the needs of the country. At present, however, 1921 is behind 1914, and if production during the remainder of the year is maintained at the rate since January 1, the total output for 1921 will be only 393,000,000 tons. The most recent year in which less than 400,000,000 tons would have been sufficient was 1909.

CANADA IRON FOUNDRIES.

The fiscal year of Canada Iron Foundries ended last month but some time must elapse before the results of operations can be determined.

Meantime, from statements made during the year and from a knowledge of conditions generally existing throughout the industrial world and more especially in the iron and steel trade, it is evident that the company suffered in common with other concerns in the same line of business.

Canada Iron Foundries owns a number of plants well distributed over the eastern half of Canada. At Three Rivers is a foundry where castings and iron pipe are made, such as is used for the distribution of water in cities and towns. At Fort William is situated a pipe foundry, as well as a car wheel factory and the manufacture of car wheels is also carried on at Hamilton and St. Thomas, Ont.

During the year, there was a considerable falling off in demand for all the Company's products. Although expansion continued in the various cities and towns of Canada, the municipalities experienced difficulty in obtaining money at reasonable rates and every effort was made to delay the extension of new streets and the laying of new water pipe until borrowing could be carried out at a lower rate of interest. In consequence, demand for this important branch of the company's business fell off to a minimum.

In addition, considerable competition from abroad was met with and in some instances, freight rates to convenient points gave competitors from United States an advantage which was difficult to overcome.

In the case of the car wheels department, the two great buyers, viz.: the C.P.R. and the C.N.R. were practically out of the market most of the time. Conditions amongst the railway companies throughout the year are known not to have been such to encourage large purchases of rolling stock. Of late, there has been some improvement in this respect. Orders for rails have been given out more freely and there is reason to think that there will be an increase in demand from this forward. Should this prove to be the case, the demand for rolling stock will naturally mean an improvement in the demand for car wheels.

All things considered, the company had a more successful year than anticipated. It has been working off its high-priced material and finds itself in good shape to meet the demand for its products, which is now beginning to be felt and which it is hoped will increase from this forward.

BRITISH INDUSTRIES FAIR 1922.

The London Section of the Fair will, as in 1921, be London and Birmingham (Eng.) from the 27th February to the 10th March next. It is organized by the Department of Overseas Trade and is Great Britain's annual display of her manufactures and industries, and the trade's opportunity of selecting goods for the next season's trade.

Te London Section of the Fair will, as in 1921, be housed in the White City, an enormous range of exhibition buildings within a few minutes of the centre of London, and connected with every part of the London area by trains, omnibuses and trams, while the Birmingham Section will again be in the great buildings of the Castle Bromwich Aerodrome, which may now be regarded as permanent Exhibition Buildings, within easy reach of the centre of the city.

Not only are both sections of the Fair, in London and Birmingham, in each instance under one roof, but it has been found possible so to arrange matters that the various trades are themselves in separate but adjoining buildings, with the result that the buyer need not waste time wandering through section after section which does not interest him.

The careful grouping of exhibitors according to their various trades is of the greatest help to the buyer, as he finds side by side with well-known firms, businesses of which he has probably never heard, but which are of equal interest. To the trade buyer new sources of supply are as important as are new markets for a manufacturer.

Another great advantage enjoyed by the buyer who visits the British Industries Fair is the fact that participation in it is confined to manufacturers. There is therefore no duplication and no confusion caused by finding identical articles unnecessarily repeated at different prices on different stands. This does not mean that merchants do not do business in connection with the Fair, for many exhibitors prefer to pass orders, particularly those for export, through merchant houses who have special facilities for handling them.

Another point which it is important that the buyer should remember is that the Fair provides a great stimulus to competition. With all the principal manufacturers in an industry side by side rivalry is naturally very keen, and the buyer profits accordingly, especially when he comes from a market which is new to the exhibitor and which the latter is anxious to enter.

Especial attention is directed to the impressive and comprehensive display of metals, hardware and engineering exhibited at the Birmingham Section of the Fair. Here the goodwill possessed by the manufacturers of Birmingham throughout the world takes tangible form, and the buyer may inspect everything of interest produced in what is universally acknowledged to be the "Workshop of the World."

CANADA AND BRITISH MACHINE TOOLS.

In a recent issue of the Iron and Coal Trades Review, of London, Eng., attention is drawn editorially to the fact that the British Trade Commissioner in Canada and Newfoundland, in his recent Report on the Conditions and Prospects of British Trade in Canada, remarks that United Kingdom manufacturers cannot be said to have neglected altogether the Canadian market, but in the majority of cases the efforts have been somewhat spasmodic and generally rather superficial. The machine-tool trade is certainly important, and the British Trade Commissioners have devoted considerable time and attention to obtaining reliable and authentic information on this subject for the benefit of United Kingdom manufacturers. In speaking of the machine-tool trade, heavy machine tools, machine tools proper, and small tools and supplies are included.

In the opinion of the manager of the largest house in the trade in Canada, the article in question proceeds, there has been no change in the purchase of machine tools from the United Kingdom during the past twelve months. His firm have endeavoured to secure prices from the British manufacturers to compete against the United States manufacturers, but British prices are much higher and deliveries uncertain. However, during the past few months it has been indicated that this situation has improved, but prices are still high, especially on heavy machine tools for railroad shops, shipbuilding plants, etc. There has been an increase in the purchase of supplies, such as anvils, vices, twist

drills, files and similar lines for the quality of the goods is equal, and in many instances superior, to that of American manufacture; prices are lower, and, moreover, the exchange has been in their favour.

British manufacturers (the article goes on to say) are not meeting the requirements of the Canadian market in machine tools, and seldom in standard supply lines. They have neglected the Canadian market for many years, and they have not made any appreciable effort to effect sales, simply being satisfied to secure an order here and there. Up to the present time it has been exceedingly difficult to interest prospective buyers in machine tools of British make, not because of quality or workmanship, but for the reason that if the British-made machine tools should break down, and the breakage require repair parts, a considerable period of delay would be occasioned, for no stock of parts is carried in Canada, and the machine tool would be obliged to lie idle until such time as the necessary parts could be secured from home. This condition applies, not only to machine tools, but to many other goods of a similar nature, where parts are wearing out and have to be replaced.

The United States has secured the Canadian machine-tool business for many years, because manufacturing conditions in Canada are similar to those of the United States, and Canadians have naturally adapted themselves to the use of American machine tools. British manufacturers must meet the situation satisfactorily in order to retain their connections, and it should not be difficult for them to overcome present conditions in Canada. Therefore, if British manufacturers desire to secure Canadian trade they should study the peculiar requirements of the market, and supply machinery and equipment for the trade in Canada, and not that which is satisfactory for use in the British market. To quote an instance: Files in the United Kingdom are about twice as thick and twice as heavy as the files to which the Canadian mechanic has been accustomed.

Owing to the fact that the Canadian mechanic has been educated in the use of United States tools, and also on account of the accessibility of supply, most machine tools are still being imported from the United States. Moreover, there are in Canada many mechanics of United States citizenship who have come over at different times upon the establishment of branch houses of United States firms, and there are hundred of such branch plants. Representatives of these firms, who are specialists in their line, make weekly or monthly trips all over Canada, visiting their jobbers or dealers who stock United States tools, and calling upon prospective customers with salesmen in the employ of their dealers. British manufacturers, on the other hand, even though they have agents resident in Canada, seldom send out a representative from home. In one particular instance an English firm, represented in Canada by important machinery dealers, took seven years to send out a representative from the other side.

Owing to the establishment of these American branch houses in Canada there had been a reduction in importation of supplies from the United States, particularly in regard to reamers, files, vices, etc., but these, though they may now be considered Canadian products, are really of American origin. Although the above are the views of one man, they are fully corroborated by other firms engaged in the same trade in Canada.

While certain United Kingdom machine-tool makers have given sufficient attention to the Canadian market to send out a special representative on a visit of inspection, the amount of trade in these lines which is at present going into foreign countries, and which could be secured by United Kingdom firms, merits further action. In practically every instance the representative has been pressed for time, and has confined himself to calling upon the principal dealers, instead of going to actual users and seeing for himself the types of tools required. Until United Kingdom manufacturers are certain that they are making articles which are suitable for the Canadian market it is much better for them to send out responsible men from the works side instead of from the sales department. Such a man should study in detail the requirements of the Canadian trade, and he would then be in a position on his return home to introduce any changes in type or construction which might be necessary to render the articles suitable for this market. The majority of representatives who come out are much handicapped, for they are simply salesmen and find it an almost impossible task to sell tools of a style and pattern unsuitable to the requirements of Canada.

There is one other point in connection with machine tools which should be impressed upon the United Kingdom manufacturer. The majority of the machine tools are made unnecessarily substantial. For example, the Canadian user does not want a lathe which will last ten or twenty years, for he considers that long before this time improvements will have been made. He would prefer to purchase one at a lower price and of less substantial construction, which would give him food and efficient service for two or three years. At the end of this time he would scrap his old lathe, and buy a new one which would incorporate all subsequent improvements. On many occasions it has been pointed out to the Commissioner that machine-tool makers in the United Kingdom have a large amount of unnecessary metal in their tools, and it is contended that tools coming from foreign countries are equally efficient in performing the work, but are much lighter and cost considerably less.

URGES EXCHANGE OF DOM. STEEL STOCKS.

Roy M. Wolvin, President of the Dominion Steel Corporation, has addressed a letter to shareholders urging them to exchange their common stock into that of British Empire Steel Corporation, at the earliest possible date.

Accompanying the letter is a memorandum prepared in response to enquiries as to the standing of holders of certificates for common shares of the Dominion Steel Corporation.

Mr. Wolvin says in part:

"The importance of prompt action is obvious, as the existing facilities for trading in common shares of Dominion Steel Corporation may be terminated at any time and the stock removed from the Stock Exchange list.

"It is desirable that such action should be taken and that trading should be confined to British Empire Corporation, which have in fact superceded the common shares of this Company. In my opinion, this would have a favorable effect, and would enure to the benefit of all concerned.

Production of Iron and Steel in Canada

September, 1921.

Pig Iron and Ferro-Alloys.

The Mining Branch of the Dominion Bureau of Statistics reports that the production of pig iron and ferro-alloys in Canada during the month of September showed a slight decline from the amount reported for the preceding month. The output of pig iron during September amounted to a total of 43,709 long tons as compared with 50,156 tons in August. The whole of the decline was in the output of basic pig iron made by firms for their own use, the quantity reported for this purpose being 38,590 tons, a decline slightly more than 8,000 tons from the preceding month. Production of basic iron for sale was small, but 409 tons was produced for this purpose. Foundry iron production for sale rose to 4,541 tons as compared with 1,785 tons in August. No malleable iron was made during the month. Electric iron remained about the same at 103 tons.

Ferro-alloys produced during the month amounted to a total of 911 tons all of which was ferro-silicon made in electric furnaces and produced by makers for direct sale. The production of ferro-silicon during September was therefore about 50 tons less than during the preceding month, and owing to the fact that no spiegeleisen was made, in September, the total production of ferro-alloys shows a very marked decrease from the August figures. There was no change in September of the number of furnaces in blast. There were, therefore, five furnaces operating at the close of the month, namely: two at Saut Ste. Marie, one at Hamilton, and two at Sydney. This leaves fifteen furnaces idle throughout the month.

The total output of pig iron during the nine months ending September, amounted to 457,157 tons, or slightly over 63 per cent of the amount produced during the same period in 1920. The production for the half year amounted to 69 per cent of the total for the same period in 1920.

The past three months have been very quiet in the iron trade, but there has been a gradual improvement in the steel industry of United States during the past two months, and as the trend of Canadian output parallels that of the United States, it is probable that a gradual improvement will be noted during the closing months of the year.

Table 1 (a) shows the production of pig iron by grades and ferro-alloys during the month. For comparison, Table (b) shows the corresponding data for the month of August, and Table 1 (c) shows the total output for the nine months of the calendar year to date.

No. of blast furnaces:

	First of Month	End of Month
Active	5	5
Idle	15	15

Table 2 (a) shows the average monthly production of pig iron in Canada for the ten-year period from 1907 to 1916, inclusive, and Table 2 (b) shows the actual production by months for the years 1917 to date.

TABLE 2 (a)

Average Monthly Production of Pig Iron in Canada.
1907-1916.
In 1000's of Long Tons.

Year	Monthly Average
1907	48
1908	47
1909	56
1910	60
1911	68
1912	75
1913	84
1914	58
1915	68
1916	87

PIG IRON AND FERRO-ALLOYS PRODUCTION (Tons of 2,240 lbs.)

	In Blast Furnaces For Own Use	In Blast Furnaces For Sale	In Electric Furnaces For Own Use	In Electric Furnaces For Sale	Total Production
Table 1 (a) September 1921.					
Pig Iron:					
Basic	38,590	409	......	...	38,999
Foundry	66	4,541	......	....	4,607
Malleable	......	....	......	....	....
Castings	......	....	......	103	103
Total Pig Iron	38,656	4,950	......	103	43,709
Total Ferro-Alloys	......	....	......	914	914
Table 1 (b)—August—1921.					
Pig Iron:					
Basic	46,852	87	......	...	46,939
Foundry	97	1,785	......	...	1,882
Malleable	......	1,234	....	....	1,234
Castings	......	....	.....	101	101
Total Pig Iron	46,949	3,106	.....	101	50,156
Total Ferro-Alloys	2,453	94	.....	967	3,514
Table 1 (c)—Total for the nine months ending September, 1921.					
Pig Iron:					
Basic	346,538	663	......	....	347,201
Foundry	33,015	47,518	222	..	80,755
Malleable	7,837	20,976	..	..	28,813
Castings	......	....	....	388	388
Total Pig Iron	387,390	69,157	222	388	457,157
Total Ferro-Alloys	9,583	167	....	8,948	18,698

TABLE 2 (b)

Total Production of Pig Iron in Canada by Months

From 1917 to Date.

(In 1000's of Long Tons)

Month	1917	1918	1919	1920	1921
January	80	66	93	73	41
February	75	70	78	64	58
March	93	86	82	69	60
April	90	93	83	77	39
May	97	94	74	87	56
June	89	92	59	80	55
July	83	98	54	84	54
August	90	86	60	93	50
September	90	85	51	94	44
October	92	96	50	105	
November	87	95	65	94	
December	78	106	70	54	
					To date
Total	1044	1067	819	974	457
					To date
Monthly Average	87	89	68	81	51

Steel Ingots and Castings.

Reflecting the low output of pig iron during September, the production of steel ingots and castings declined from 72,023 tons in the preceding month to 56,447 long tons in the month now under review. The whole of this decline was in the output of basic, open hearth steel ingots, production of bessemer ingots and electric steel remaining at about the same level as during August.

Basic open hearth castings showed a small improvement rising from 770 tons in August to 853 tons in September. Bessemer castings were about the same at 140 tons, while electric steel castings rose slightly from 812 tons to 975 tons. Of the steel ingots and castings produced during the month, 54,754 tons was made by firms for their own further use and 1,692 tons was produced for sale. The latter figure shows an improvement of about 300 tons from the amount reported for the preceding month.

The total output of steel ingots and castings for the nine months ending September amounted to 477,588 long tons as compared with 845,000 tons during the first three-quarters of 1920. The output for this year is, therefore, equal to about 57 per cent of the quantity made in the same time last year.

During the nine months, the output of steel ingots totalled 459,960 long tons while steel castings amounted to 17,628 long tons. Makers produced for their own consumption 459,249 long tons of steel ingots of which 457,358 tons was basic open hearth steel, the balance being electric, acid open hearth or bessemer product. During the same time, 3,423 tons of castings was made and used, while a total of 14,205 tons of direct steel castings was produced for sale. Of this latter amount, 10,890 tons was made in electric furnaces, the balance being made by basic open hearth, bessemer or acid open hearth process.

Table 3 (a) shows the production of steel ingots and castings during the current and preceding month, and Table 4 (b) shows the total output for the nine months ending September. Tables 4 (a) and 4 (b) show the monthly outputs of steel ingots and castings for the past fifteen years.

TABLE 3 (b)

Total Production of Steel Ingots and Castings.

For the Nine Months ending September, 1921.

	For Own Use	For Sale	Total Production
Steel Ingots:			
Open Hearth-Basic	457,358	......	457,358
Acid	239	......	239
Bessemer	34	51	85
Electric	1,618	660	2,278
Total Steel Ingots	459,249	711	459,960
Steel Castings:			
Open Hearth-Basic	1,017	3,045	4,062
Acid	4	252	256
Bessemer	212	1,118	1,330
Electric	2,190	10,890	11,980
Total direct steel castings	3,423	14,205	17,628
Grand Total	462,672	14,916	477,588

TABLE 4 (a)

Average Monthly Production of Steel Ingots and Direct Steel Castings in Canada, 1907-1916.

In 1000's of Long Tons.

Year	Monthy Average
1907	53
1908	44
1909	56
1910	61
1911	66
1912	71
1913	87
1914	62
1915	76
1916	106

TABLE 3 (a)

Production of Steel Ingots and Castings in Canada for the Current and Preceding Month.

(Tons of 2,240 lbs.)

	August For Own Use	August For Sale	August Total	September For Own Use	September For Sale	September Total
Steel Ingots:						
Open Hearth-Basic	70,088	.....	70,088	54,320	.....	54,320
Acid	......	.....	......	......	.....	......
Bessemer	2	3	5	2	1	3
Electric	241	5	246	156	.....	156
Total Steel Ingots	70,331	8	70,339	54,478	1	54,479
Steel Castings:						
Open Hearth-Basic	287	483	770	159	694	853
Acid	......	.....	......	......	.....	......
Bessemer	6	96	102	10	130	140
Electric	64	748	812	107	868	975
Total direct steel castings	357	1,327	1,684	276	1,692	1,968
Grand Total	70,688	1,335	72,023	54,754	1,692	56,447

TABLE I b

Total Production of Steel Ingots and Castings in Canada by Months.

From 1917 to Date

(In 1000's of Long Tons

Month	1917	1918	1919	1920	1921
January	117	130	107	92	40
February	108	124	90	84	59
March	136	141	100	97	53
April	125	149	75	93	27
May	139	156	69	90	52
June	122	118	68	91	64
July	124	147	66	94	54
August	130	152	54	105	72
September	133	149	60	99	56
October	144	164	66	111	
November	141	116	82	97	
December	139	105	87	56	
					To date
Total	1558	1681	924	1109	477
					To date
Monthly average	130	140	77	92	53

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES.

Meets in Toronto, December 27 to 31, 1921.

The seventy-fourth meeting of the American Association for the Advancement of Science will be held at Toronto, Canada by invitation of the University of Toronto and of the Royal Canadian Institute.

It may be safely predicted that the seventy-fourth meeting will be exceptionally interesting and inspiring on account of its international character. More Canadian men of science will attend than is usual for meetings held south of the international boundary, and the scientific workers of the two great English speaking nations of North America will here have opportunities for becoming even better acquainted than they now are, and for strengthening the bonds of mutual understanding and of personal and national friendship. Arrangements are in progress whereby, it is hoped, several British scientists may be present and give addresses at the various sessions of the second Toronto meeting.

The President of the Association for this year is Professor Eliakim H. Moore, of the University of Chicago, one of the distinguished mathematicians who have given American mathematics its prominent place in world science. Professor Moore will preside at the opening session, Tuesday evening, December 27, at which Doctor L. O. Howard, of the United States Department of Agriculture will present his address as Retiring President of the Association. Dr. Howard is well known to American scientists, through his excellent scientific work and in the organization of the United States Bureau of Entomology, as well as through his untiring services to the advance of science and education during his long and successful period as Permanent Secretary of the Association.

Many affiliated, or otherwise associated, scientific societies will meet with the Association at Toronto, for the reading of papers, for scientific discussion, and for the presentation of presidential addresses, and the sections of the Association will also hold sessions in many instances. The Association is becoming increasingly an affiliation and cooperative organization of the numerous special scientific societies of America and it is provided that the affiliated societies meeting with the Association shall have charge of the programs for the presentation of papers in their respective fields. Each of the retiring Vice-Presidents of the Association, one for each of its sections, will present his scheduled address on some aspect of his own special province.

ELECTRIC SMELTING OF IRON ORE

By FRANK HODSON

President Electric Furnace Construction Co., Philadelphia.

A statement was made at a recent meeting of the officers of the American Mining Congress in Washington by Charles W. Potts, mine operator, of Bearwood, Minn., that "Present known reserves of high-grade iron ore, based upon constantly expanding requirements of the steel industry, will be exhausted in twenty years, and the merchantable grades of iron from the great mines of Minnesota will be, at the present rate of depletion, practically exhausted within the next fifteen years unless new discoveries are made."

The tremendous significance of this rapid depletion of native high-grade iron ore has not yet been fully realized, but a glance at the capital invested in iron and steel and kindred industries and its importance nationally will make anyone see the gravity of the situation. As in the olden days the possessors of metals ruled the world, so today control of iron is inseparably linked with world leadership. If, as Mr. Potts states, our available high-grade ore will be depleted in twenty years, is there not also a grave danger of our position today in the world's markets passing, unless the vast deposits of iron sands and low-grade ores in this country are properly exploited? Other countries—China, Japan, Brazil, India—with cheap labor, have immense deposits of iron ore. They have water power available and already are installing large smelting furnaces operated electrically for reducing the iron ores.

Commercial Feasibility of Electric Smelting of Low-Grade Iron Ore.

The electric smelting furnace — using cheap water-generated power — will very probably in the next few years open up a vast supply of iron ore at present considered almost worthless. Immense deposits of iron sands and low-grade ores occur in the Adirondacks, on the Pacific Coast and in many other parts of the country. These ores are at present useless, as they cannot be economically treated in the ordinary standard blast furnace. Most of these deposits are in places where power is, or could be generated very cheaply; the ore can be concentrated and smelted into iron by specially designed electric furnaces.

The one thing essential after the financial backing is obtained is the selection of the right type of equipment for the work. Many previous attempts to smelt these ores electrically have failed, owing to wrong or no proper technical advice. A recent issue of *The Foundry* stated there are no less than seventy so-called "direct" processes, for making steel direct from ore. Some of these are feasible under certain conditions, but they should not be attempted except on advice from disinterested metallurgists who have had practical electric smelting experience. These "direct" and "secret" processes to give steel direct from ore are the snag that has sunk many promising ventures.

There are several known and proved processes for electric iron smelting, chief of which is the Swedish Electrometall process. Already twenty-seven large in-

stallations, with a total capacity of 100,000 kw., are running or under construction in various parts of the world. This type of electric smelter uses the gases generated in the melting zone to preheat and partly reduce the charge; it does not attempt to make steel direct, but in several cases the product is being tapped out into metal mixers or open hearth furnaces and from there into finishing electric furnaces. Dr. Stansfield in his report on the commercial feasibility of electric smelting of iron ores in British Columbia, writes:

"In Sweden the Electrometall type of electric smelting furnace has proved very satisfactory for the production of low-silicon pig iron. This is, as far as I am aware, the only type of electric furnace that has ever attained commercial success in the production of pig iron from ores. If a permanent smelting plant were being erected, the Swedish type of furnace would be selected."

Considerable publicity has been given recently to what was termed a recent Japanese discovery that iron sand and low-grade ores could be smelted and made into steel. There is nothing new in this invention; as long ago as 1907 John T. Jones, of Iron Mountain, Mich., had devised a similar process for treating low-grade ores. H. A. Greaves and H. Etchells, English scientists and inventors of the successful "Greaves-Etchells" electric steel furnace, also brought out a process a few years ago, in which black iron sand was passed down a rotating tube or kiln and from there to a finishing electric furnace. The ore in this tube is preheated and partly reduced by the gases given off in the electric furnace, and finished steel from sand and has repeatedly been made by their process.

A French inventor, Monsieur Basset, uses a similar method, but in his case external or additional heat is applied to the ore proceeding through the preliminary tube.

Advantages of Electrically Made Pig Iron.

As long as high-grade ore is available and coke reasonable in price, these electric processes of ore reduction cannot hope to compete with the standard blast furnace in anything but charcoal iron — or iron of special analysis. With the falling off in available supplies of high-grade ore and the generation of cheap electric power from water power, the electric smelters will come into their own. They can undoubtedly make iron superior in quality to that made in the standard blast furnaces. Very thorough tests made in Sweden and England with this electrically made pig iron also proved that by its use in the open-hearth furnaces considerable time could be saved in the steel-making operations. Actual figures have not been published, but in a number of cases that came directly under the writer's notice the saving in time per heat of steel was between 1½ and 3½ hours.

Although, therefore, the initial cost of electric pig iron may still be somewhat higher than ordinary blast-furnace pig iron, yet considerations such as that mentioned above and the extreme purity of the electric iron do not make the difference in first cost as large as would at first appear.

The electric smelter can also economically handle a very large proportion of turnings, borings and cheap scrap in its charge — material that is not suitable except in small proportions in the standard blast furnace.

In places like the Pacific Coast, where good ore is available near cheap, water-generated electric power and where at present most of the coke, pig iron or steel has to carry heavy freights from the East, there is a splendid opening for someone with vision ahead to put down electric smelters and steel plant.

Commercial Feasibility of Electrically Made Steel.

Probably the future method of making even cheap steels will be to take hot blast-furnace metal, either from electric or standard blast furnaces, directly into a large metal mixer where additions of ore, cheap borings and turnings could be added, from there to a bessemer converter, where the metal would be given a partial blow only, and the deoxidizing and finishing off would be done very quickly in a series of electric furnaces.

In the process outlined there would be practically no loss of heat in the whole operation, the addition of ore and cheap scrap in the form of borings, etc., in the mixer would cause a thermic reaction and generation of heat, the bessemer operation would add more heat, and all that the electric furnace would have to do would be to deoxidize, adjust temperature and, where necessary, refine or make additions of alloys. The writer is confident this process would make the cheapest steel in the world.—*Chemical and Metallurgical Engineering.*

IRON AND STEEL RAIL HISTORY.

Announcement last week of a common price of $40 for Bessemer and open-hearth rails recalls, says "Iron Age" of the 3rd instant, the very interesting statistical history of these two products and also that of iron rails. The open-hearth rail was not an important factor for a good many years after the total of open-hearth ingots had become considerable. Until 1877 more iron rails than steel were rolled, and it was not until 1883 that the mileage of steel rails in track exceeded that of iron rails—78,491 miles against 70,692 miles. In 1978 the production of Bessemer rails was 610,682 gross tons, while only 8,168 tons of open-hearth rails were rolled, and the production of iron rails was 375,143 tons. In 1883 the production of open-hearth rails was 8,202 tons and that of iron rails had declined to 57,994 tons, while the output of Bessemer rails was 1,148,709 tons. In 1890 production of Bessemer rails was 1,867,-837, that of iron rails 13,882 tons and that of open-hearth rails 3,588 tons. Production of open-hearth rails increased until in 1907 it amounted to 252,704 tons, while 3,380,025 tons of Bessemer rails were rolled and only 925 tons of iron. Open-hearth, with a production of 1,676,923 tons, passed Bessemer in 1911, when the Bessemer output was 1,053,420 tons. The open-hearth output reached its highest point in 1913 with 2,527,710 tons compared with 817,591 tons of Bessemer. Manufacture of iron rails ended with 234 tons in 1911. Bessemer tonnage declined in 1920 to 142,899 compared with 2,334,222 of open-hearth. A considerable part of the Bessemer tonnage now rolled is light rails.

In 1906 the price of open-hearth rails was fixed at $2 higher than that of Bessemer rails. The latter had been selling since 1901 at $28 and the price was not changed until May, 1916, when there was an advance of $5. The differential of $2 was maintained by independent companies until last week, although recently ignored by the Steel Corporation. If the new price of $40 be compared with $30 before the war, it represents very nearly the same percentage above the pre-war price as is now maintained on other steel products.

Holley many years ago predicted that the open-hearth would one day attend the funeral of the Bessemer converter, and more recently the passing of the Bessemer has been predicted on the basis of its diminishing percentage, the production of open-hearth steel in 1920 having been 32,671,895 tons, compared with 8,883,087 tons of Bessemer. As has been pointed out frequently, the employment of the Bessemer pro-

use of Bessemer steel for certain purposes is likely to continue. The clean threading of Bessemer steel pipe commends it, and British importers of American skelp continue to call for the Bessemer product. The advantage of Bessemer steel in rolling tin plate and sheets is also well known. And as long as duplexing continues to expand, with its large outputs, its freedom from dependence on scrap and its necessary employment where the only available ores run up silicon beyond the basic limit, there will still be a call for the Bessemer converter.

A NEW ROASTER.

A modification of the ordinary McDougall roasting furnace has been developed at the Copper Queen smelter at Douglas, Ariz., and is described in a paper prepared by J. M. Samuel for the American Institute of Mining and Metallurgical Engineers, entitled the "Queen Hearth Roaster."

The following assumptions were made in the development of the design of the new plant: (1.) Outside diameter to be 18 ft. (limited by size of building). (2.) Sulphur elimination to be 30 lb. per sq.ft. of hearth area per twenty-four hours (standard practice at the Calumet and Arizona smelter). (3.) Outgoing gases to contain 5 per cent sulphur dioxide by volume. (Higher content of sulphur dioxide has been found to result in decreased capacity). (4.) Gas velocity through ports not to exceed 10 ft. per second. (With low gas velocity a given draft will draw more air through the furnace, and also less trouble will be had from accretions).

Conservation of heat was obtained by building the bottom hearth of Kieselguhr insulating brick and providing space for a reasonable bed of roasted ore. Lateral radiation losses were taken care of by backing the walls between skewbacks with a layer of insulating brick and also by reducing the distance between hearths to a minimum. The close hearth spacing was obtained in the following ways.

1. A conical arch with a rise of 25-32 in. per ft. was used, fire brick of special shape being used in the construction. In addition the arches were tapered from 8 in. thick at the outer end to 4 in. thick at the inner.

2. The arms were set parallel to the arches and were made of 6-in. steel casing.

3. The clearances were reduced to 3½ in. as the minimum allowance between the rabble teeth and the hearth; also between the top of the arm and the underside of the hearth roof.

The top hearth was made of cast-iron plates, to allow a minimum transfer of heat from the outgoing gases to the incoming ore. Six rabble arms were used on this hearth, with 12-in. blades set at between 20 and 30 deg.

Inasmuch as probably 40 to 50 per cent of the sulphur oxidation takes place as the ore drops from one hearth to the next, special attention was paid to securing a proper amount of air at the drop holes. Also, oxidation is promoted by frequent stirring. For that reason the roaster was equipped with a variable speed motor, so that any speed between one revolution in twenty seconds and one in fifty- five seconds could be obtained.

Tests of the new roaster showed considerably increased capacity, especially with a feed low in moisture. Low moisture also results in increasing the temperature of the product and increasing the sulphurdioxide content of the outgoing gases.

EXPERT FOR TORONTO UNIVERSITY.

Mr. E. A. Allcut Joins Staff as Professor in Department of Thermo-dynamics.

Toronto gains another useful citizen in the arrival recently of Mr. E. A. Allcut, the new Associate Professor in the Department of Thermo-dynamics, University of Toronto. Prof. Allcut is well qualified for the position, having graduated from Birmingham University with honors in chemical engineering. Later he took the M.Sc degree, the Bowen Research Scholarship, and the Heslop Gold Medal. The results of his research work on producer gas were read before the Institution of Mechanical Engineering. He is an associate member of both the Institute of Mechanical Engineers and the Institution of Civil Engineers, as well as Associate Fellow of the Royal Aeronautical Society. For 15 years he was engineering lecturer in the Smethwick Municipal Technical Institute.

Prof. Allcut was associated with the early experimental work on the Humphrey internal combustion pump. Later he was manager of the engineering and testing machine departments of W. & T. Avery, Ltd., of Birmingham. This department was the original shop of the old firm of James Watt & Company. During the war Prof. Allcut designed a large number of special machines for testing materials used in the construction of aeroplanes, aeroplane engines, shells, etc. At the close of the war he became Chief Inspector of Materials for the Austin Motor Company of Northfield, and was sent last year to France to reorganize the tractor plant of the company near Paris. On his return he set up in practise as a consulting engineer. Prof. Allcut is a Freemason and a prominent Wesleyan Methodist.

WORK ON MANITOBA POWER DEVELOPMENT.

The first units of the Manitoba Power Company's $10,000,000 power development scheme on the Winnipeg River have been started by Fraser Brace Construction Co., of Montreal, and preparatory work will be pushed during the winter, said James H. Brace. Large contracts for materials will be placed and other organization work completed this winter, so that everything will be in readiness for actual construction work early in the spring.

As already announced, the Fraser Brace Company has been awarded the contract for $7,500,000, covering practically all construction of development scheme, and since the completion of the financial arrangements, has assumed command of the works on the Winnipeg River.

A. W. McLimont, Vice-President of the Winnipeg Electric, who has returned from Montreal, expresses himself as satisfied with financial and other arrangements made in connection with the new power company.

INSTITUTE OF CHEMISTRY.

The first meeting of the session of the Queen's University branch of the Canadian Institute of Chemistry was held in Gordon Hall, Kingston, Ont., on Tuesday, Oct. 25. The Kingston branch of the Institute was formed last spring. Although many of the members of the staff of the department of the chemistry at Queen's University were already members of the Institute, it is understood that Queen's has the distinction of being the first university to form a student branch.

KERR LAKE ANNUAL MEETING.

Toronto, 27th Sept.—Kerr Lake Mining Company held its annual meeting recently in New York, and, according to wire information received by Hamilton B. Wills and Company, company income for the year ending August 31 totalled $195,820, as compared with $1,091,282 during the 1920 fiscal year. The financial report presented to shareholders contained comparisons between the last two years as follows:

Total income	$ 195,820	$1,091,282
Expenses	143,355	473,230
Deficit	560,325	473,653
Previous surplus	1,962,966	2,436,619
Total surplus	1,402,641	1,962,966

Reports for last year:—Total income, $610,243; expenses, $131,264; balance on hand, $478,979; dividends paid during year, $300,000, leaving a total net surplus of $178,979.

The old board of directors was re-elected for this year.

The low price for silver during the year just closed greatly interfered with the company's operations, and with this metal market steadily advancing the outlook for the current year is considered more hopeful.

SMELTER OFFICIALS CONFER WITH MINE OPERATORS.

Problems mutual to the Consolidated Mining and Smelting Company of Canada and the independent silver-lead mine operators furnished the theme for discussion at a conference in Nelson, B.C., between the representatives of the mining corporation and the principal operators.

The operators came in response to an invitation to discuss subjects that it might be "of mutual advantage" to consider.

From the point of view of the Consolidated, it was explained that it was a long time since the company had met the operators in conference, and that a talk over the situation would be a good thing.

The company was represented by J. J. Warren, president; S. G. Blaylock, general manager, and T. W. Bingay, comptroller. The operators at the conference included Clarence Cunningham, Alamo; James Anderson of the Ruth; W. E. Zwicky, of the Cork-Province; S. S. Fowler, of the Blue Bell; John B. White and Oscar White, of the Silversmith; W. A. Cameron, of the Rambler-Cariboo; J. P. McFadden, of the Roseberry-Surprise; Paul Lincoln, of the Noble Five, and Randolph Bruce, Invermere.

Messrs. Warren and Blaylock, after the conference, went on board the Crow boat, to proceed to Kimberley. Mr. Bingay returned to Trail.

AMERICAN FIRMS SELL ROLLING STOCK TO ARGENTINA.

A joint contract was secured last week from the Argentina State Railways by Baldwin Locomotive Works and Middleton Car Company, a subsidiary of the Standard Steel Car Company, for railroad equipment costing $13,000,000. The contract, which is subject to the approval of the President of the republic, calls for the delivery of 85 locomotives and 2,000 freight cars and spare parts. Five-year Treasury notes of the Argentina Government bearing 6 per cent. were accepted by the companies in payment. Two German corporations were competing for this business.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

Accumulators, Hydraulic:
Smart-Turner Machine Co., Hamilton, Ont
The Dominion Steel Products Co., Ltd., Brantford, Can.

Air Compressors:
R. T. Gilman & Co., Montreal.

Aluminum:
A. C. Leslie Co., Ltd., Montreal.

Angle Bars:
Steel Company of Canaa, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Barbed Wire Galvanized:
Steel Company of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Anchor Bolts:
Steel Company of Canaa, Ltd., Hamilton, Ont.

Axles, Car:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
United States Steel Products Co., Montreal.

Axles, Locomotive:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
United States Steel Products Co., Montreal.

Barrel Stock (Black Steel Sheets):
Seneca Iron & Steel Co., Buffalo, N.Y.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bars:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
United States Steel Products Co., Montreal.

Bars, Iron & Steel:
Manitoba Steel & Iron Company
Canadian Western Steel Co., Calgary, Alta.
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Ferguson Steel & Iron Co., Buffalo, N.Y.
The Steel Company of Canada, Hamilton, Ont.
Beals, McCarthy & Rogers, Buffalo, N.Y.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Canadian Drawn Steel Co., Ltd., Hamilton, Ont.
Canadian Tube & Iron Co., Ltd., Montreal.
Leslie, A. C. & Co., Ltd., Montreal.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bars, Steel:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Billets, Blooms and Slates:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Steel Company of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Belting, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Benzol:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Steel Company of Canada, Ltd., Hamilton, Ont.

Binders, Core:
Hyde & Sons, Montreal, Que.

Bins, Steel:
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
Reid & Brown Structural Steel & Iron Works, Ltd., Toronto
Toronto Iron Works, Toronto, Ont.

Black Steel Sheets:
B. & S. H. Thompson & Co., Ltd.
Seneca Iron & Steel Co., Buffalo, N.Y.
Leslie & Co., Ltd., A. C., Montreal, P. Que.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Blooms & Billets:
Algoma Steel Corp., Ltd., Sault Ste. Marie.
Dominion Foundries & Steel, Ltd., Hamilton, Ont.
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Boilers:
Sterling Engine Works, Winnipeg, Man.
R. T. Gilman & Co., Montreal.

Bolts:
Baines & Peckover, Toronto, Ont.
Steel Co. of Canada, Hamilton, Ont
Canadian Tube & Iron Co., Montreal, P.Q.

Bolts, Railway:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bolts, Nuts, Rivets:
Canadian Tube & Iron Co., Ltd. Montreal
Steel Company of Canada, Ltd., Hamilton, Ont.

Box Annealed Steel Sheets:
B. & S. H. Thompson & Co., Ltd.
Seneca Iron & Steel Co., Buffalo, N.Y.
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Brass Goods:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Brick-insulating:
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.

Bridges:
Hamilton Bridge Works Co., Ltd., Hamilton.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.

Brushes, Foundry, Core:
Hyde & Sons, Montreal, Que.

Buildings, Metal:
Pedlar People, Limited, Oshawa, Ont.
Hamilton Bridge Works Co., Ltd., Hamilton.

Car Specialties:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.

Carriers:
Canadian Mathews Gravity Carrier Co., Toronto, Ont.

Gaskets, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Cast Iron Pipe:
National Iron Corporation, Ltd., Toronto
Hyde & Sons, Montreal, Que.
Canada Iron Foundries, Montreal.

Castings, Aluminum:
Wentworth Mfg. Co., Limited, Hamilton, Ont.

Castings, Brass:
Wentworth Mfg. Co., Limited, Hamilton, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Bronze:
Wentworth Mfg. Co., Limited, Hamilton, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Gray Iron:
Canadian Steel Foundries, Ltd., Montreal P.Q
Electrical Fittings & Foundry, Ltd., Toronto, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Nickel Steel:
Hull Iron and Steel Foundries, Ltd., Hull, P.Q.
Canadian Steel Foundries, Ltd., Montreal P.Q.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
Dominion Steel Foundry Co., Hamilton, Ont.
Joliette Steel Co., Montreal, P.Q.

Castings, Gray Iron:
Reid & Brown Structural Steel & Iron Works, Ltd., Toronto
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Castings, Malleable:
Canadian Steel Foundries, Ltd., Montreal P.Q.
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Castings, Steel:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Cement, High Temperature:
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.

Chemists:
Toronto Testing Laboratory, Ltd., Toronto, Ont
Milton Hersey Co., Ltd., Montreal.
Charles C. Kawin Co., Ltd., Toronto.

Chucks Lathe and Boring Mill:
The Dominion Steel Products Co., Ltd., Brantford, Can.

Clip and Staple Wire:
The Seneca Wire & Mfg. Co., Fostoria, Ohio, U.S.A.
United States Steel Products Co., Montreal.

Concrete Hardener and Waterproofer:
Beveridge Supply Company, Limited, Montreal.

Consulting Engineers:
W. E. Moore & Co., Ltd., Pittsburg, Pa.
W. S. Tyler Co., Cleveland

CANADIAN CAR CO.'S ORDERS.

It was announced on the 26th of last month that the Canadian Car Company has received an order from the National Railways for the repair of 1,000 cars. W. F. Angus, Vice-President of the company, stated that 500 of these would be handled at the Amherst plant, and the same number in Montreal, and that the work would give employment to a large number of men at both plants.

It is generally believed this order will at least go some distance toward placing the company in a position to pay the dividend on the preferred stock which was deferred a little while ago. There is some expectation that further orders of this nature will be given out later. The railroads have been economizing for some time, and in the ordinary course of events a good deal of equipment will need overhauling.

Other car building companies are understood to be receiving orders in this connection.

The $2,000,000 order for new cars which Canadian Car and Foundry received two months ago from Russia was completed well before the end of last month. The first shipload of cars started loading on the 26th ult., and the fourth and last shipload was expected to leave by the middle of this month. Payment for this order was made through Stockholm, the money having been already placed in a Canadian bank at Montreal.

COCKSHUTT PLOW COMPANY.

The annual meeting of the Cockshutt Plow Company was held at Brantford on the 11th instant. The annual report, as published recently, was submitted and expression given to the feeling that under the circumstances it was a good one.

On motion of C. Cook and W. H. Webling, a resolution of congratulation to President Harry Cockshutt on his elevation to the position of Lieutenant-Governor was passed, a number of speakers adding their tributes.

The directors were re-elected as follows: His Honor Lieut-Governor Harry Cockshutt, President; George Wedlake, Vice-President and General Manager; S. E. A. Mott, Vice-President, assistant to the General Manager and Treasurer; F. Perry (Montreal), Sir Augustus Nanton (Winnipeg), H. W. Hutchinson (Winnipeg) Sir Lomer Gouin (Montreal), G. K. Wedlake (Brantford), James Adams (Brantford), directors; A. K. Bunnell, Auditor, and James Sweet, Secretary, were confirmed in their positions.

TREATING PLANT FOR SHALES.

The British Oil and Fuel Conservation, Ltd., of 9, Southampton Street, Holborn, London, W.C. 1, announce that they have taken over a large works at Willesden, where they are erecting laboratories, retorts and distilling apparatus to demonstrate their unique plant for complete low and high temperature treatment of coals, shales, and lignites, under the direction of their technical director and patentee, Mr. Nat. H. Freeman. Their laboratories and retorts are now available for testing material from British, overseas, and foreign sources. Accurate data will be given as to the maximum yield of oil, the value of the distillates and gases, and the cost of operation, while certificates of analyses and complete reports upon the best method of treatment to secure a maximum economic return will be issued. A Freeman Multiple Low Temperature Retort is being erected capable of treating 10 tons of material per day, and owners of coal, lignite and shale are notified that the company is now in a position to accept orders for 10-ton tests.

MACHINE PLANT FOR HAMILTON.

Selecting Hamilton for its Canadian factory by reason of its accessibility of supplies, good labor market, exceptionally good transportation facilities and the spirit of co-operation that exists among the civic authorities and the manufacturers, the Wallace Barnes & Co., Ltd., of Bristol, Conn., has located in Hamilton and will commence operations at an early date in the premises formerly occupied by the National Machinery & Supply Co.

The new industry is capitalized at $300,000 and will employ about 150 hands. It will specialize on all kinds of screw machine products, springs, etc. The parent company in Bristol, Conn., is capitalized at $1,510,000 and employs 500 hands. Officials of the Canadian branch are: President, Fuller F. Barnes; Vice-President, Harry C. Barnes; Secretary-Treasurer, Freeman M. Norton, and Directors, Carlisle F. Barnes and C. Victor Grantham.

IRON & STEEL

OF CANADA

PUBLISHED MONTHLY

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PROTECTION IS ESSENTIAL.

The general election has resulted in the overwhelming defeat of the party which avowed its belief in the necessity of a tariff not merely for purposes of revenue but also for the fostering and protective of Canadian industries. The Government which has now acceded to office is expected to revise the tariff at an early opportunity. It is hoped by some, and feared by others, that such revision will be in a sharply downward direction. Whether these hopes and fears (as the case may be) are justified or not there is one point on which those engaged in the iron and steel industry in this country will be practically unanimous: that is the undoubted fact that, if that industry is to survive, it must receive adequate tariff protection. Tariff protection may be, for other industries, desirable: for this particular industry it is absolutely essential. Without it, it cannot live.

Such tariff protection as the steel and iron trades in Canada have received has not hitherto been adequate to the circumstances in which they find themselves. It has, however, sufficed to keep them in being, though, so far as the primary plants are concerned, it has not been sufficient to enable them to flourish vigorously. The secondary trades, it is true, are in a different position, but they also are the creations of Protection.

The steel and iron trades in Canada occupy a position which is very likely to make them a definite object of attack by those who will press their tariff views in favor of a sharp downward revision on the Government's attention. They draw their raw materials very largely from outside this country's borders, and, in so far as they do that, the industry cannot be said to be one that is indigenous to Canada. We are free to admit that it is not based in this country on natural resources in the same way or rather to the same extent, that it is in Great Britain or the United States. Hence the fiscal purists who will endeavor to get the Government's ear will assert that it is superfluous and can be dispensed with. For our part, we deny the conclusiveness of this argument. It is our view that a well-established steel industry is conducive — indeed, essential, — to any country's industrial progress. It is a basic or key industry. And the condition of the steel industry in any country is very generally regarded as a true guide to that country's industrial prosperity and development.

On many grounds it is, in the very highest degree, advisable that, in respect to the products of its basic or key industries, a country that aspires to nationhood should preserve the greatest possible measure of independence. The war taught the nations of the world a lesson in this regard which should not be lightly dismissed by any Canadian Administration as of small account today. And, apart altogether from any question of the requirements of the exigencies of war, we have no shade of a shadow of a doubt that the existence of a steel industry of our own has had an immense, if largely an imponderable, share in fostering the sentiment of national consciousness which, in ever-increasing measure, obtains among Canadians today. Once let Canada, in so vitally important a matter as this basic or key industry, become commercially subservient to the United States, and she must be content — there is no alternative—to sacrifice, to a greater or less extent, her capacity for independent action, and to abate something considerable of her lofty national aspirations.

These are grave considerations. For our part, we decline to believe that the new Government will disregard them. That Government is composed of Canadian men. They are in a position where they must have abundant opportunity of judging of the enormous benefits, to industry and labor and to the financial position of the country, which have accrued from the development of this industry. They cannot fail, either, to be responsive to those national aspirations we have mentioned and which form so marked a feature of present-day Canadianism.

If we are right in our contention that, whatever loose talk may have been indulged in the course of the election campaign, the Government, now it is in office, cannot fail to pay regard to such considerations as those of which we have spoken, then it must retain the protection given by the tariff to Canadian steel and iron activities. We are very far from admitting that that measure of protection has, so far as the primary plants are concerned, met the circumstances of the case. And we are very conscious of the fact that the clauses relating to the steel industry in the Canadian Customs tariff are more numerous and more complicated, and, perhaps, in some ways, more discouraging than those relating to any other industry. But of this there can be no doubt: that any substantial diminution of the measure of protection now accorded would have the very gravest effect on the industry and might even (quite conceivably) result in the collapse of its entire fabric.

It is undeniable that, in the past, large steel industries in the United States have made very persistent efforts to seek business in Canada on the same footing as they sell to their domestic trade. Canada has thus been subjected to the keenest competition from producing

units with great advantages as regards capacity, and also by reason of the fact that any lessened demand from the domestic market in the United States immediately results in a concentrated effort to unload surplus products on the Canadian market. In this connection, the question of the territory and population of Canada and the United States respectively has a very important bearing on the whole matter. This is very well put in the statement submitted to the Tariff Committee of the late Cabinet, last September, by the Steel Company of Canada, which justly also lays stress on the fact that, in the steel industry, tonnage is a prime factor of economical production in large units. "Our units", says this statement, are necessarily less extensive and must be suited to the tonnage available, particularly with regard to the demands for specific sizes and kinds of products. This may be illustrated by the comparison of a modern rolling mill, largely operated by mechanical means, with an output of 12,000 to 15,000 tons a month, with the old style hand rolling mills, many of which are still in existence and having a capacity of between 1,500 to 2,000 tons per month. Between these extremes there are mills with varying capacities and naturally cost of production is dependent upon the tonnage rolled, both with respect to cost of labour, coal, power, and overhead. A mill of the most modern type, with a heavy tonnage, would be entirely unsuited to the Canadian market because such mills must be operated constantly and with few changes. Only one size can be rolled at one time and we could not hope to collect a sufficient tonnage of any one size to operate such a mill for any length of time, and therefore, frequent changes in rolls would be necessary with a consequent loss of time which would absolutely nullify the value of the investment. Such an installation of the most modern type involves an expenditure of about $3,000,000, a fact which exemplifies the cost of development in the steel industry, besides the constant necessity of making provision to discard obsolete and out of date machinery and equipment."

The steel and iron trades in Canada require protection for this reason, beyond others:—in order that the business may be developed to such an extent that production is sufficiently large to secure the economies obtainable from a larger output. It is obvious that the retention of such protection is vital to steel and iron activities in Canada, if they are to continue to survive. And that their survival is vital to the interests of the nation is, we believe, a statement of simple fact.

TEN YEARS OF PEACE.

The treaty of peace to which Great Britain, the United States, France and Japan are parties should result in the maintenance of peace in the Pacific for ten years, at anyp rate. The four powers named agree to respect one another's rights in relation to their insular possessions and dominions in the region of the Pacific, and to hold conferences in the event of disputes. This treaty is to remain in force for ten years, which will make it coterminous with the proposed naval holiday, and twelve months' notice is requisite to its termination. If any other power threatens aggressive action, the four powers that are parties to the treaty will communicate fully and frankly with each other, and take joint action.

Thus the provisions of the treaty which we have just briefly summarized are of no elaborate or pretentious character. Yet it marks the opening of a new chapter in the history of humanity. It removes the possibility of a conflict, of a nature which it is difficult even to contemplate without horror, for ten years, and it may well be for ever. For we trust, with Mr. Balfour, that it will ensure, for all time, perfect harmony of cooperation between the four powers named in the great region with which the treaty deals. This treaty is to be followed by another which will relate to the future of China and to which all the powers, including China, will be parties.

With regard to the Anglo-Japanese alliance, which will be terminated by the treaty just arranged, we are quite sure that nothing (as Mr. Balfour said) could have been farther from the thoughts of those who arranged it than that it could touch, in the remotest way, the interests of the United States. None the less, however, as he admitted, it has been the cause of much searching of heart, of some suspicion, and of a good deal of animadversion in the United States. For our part, although we are sure that there was no foundation, in the actual circumstances for any apprehension in the United States with regard to this alliance, we regard the sentiment as not unnatural, and deem it a matter for great satisfaction that it will now be wholly allayed. From the very first, we have hoped that one result of the Conference would be to draw Great Britain and the United States closer together. And we believe that the treaty now arranged will very greatly conduce to that end, while, at the same time, it will tend immensely — far more, perhaps, than it is possible even dimly to realize at the moment — to the removal of causes of friction and suspicion as between the United States and Japan.

THE NAVAL HOLIDAY.

The Washington program of a ten-year naval holiday, the announcement of which was followed by the British Government's orders for the immediate stoppage of work on the four new capital ships of the "Hood" class, has created something like consternation in the dockyards and steel-making centres of Great Britain. It seems undoubted that this sudden change in naval construction means grave industrial disturbance in these dockyards and steel-making centres. For the armament firms it must result in a certain inevitable dislocation. For the men who were already working, and for those who would have secured work, on the countermanded battleships, it will probably result in unemployment, of at least a temporary kind.

But, at the same time, it is possible that those firms

and workers in Great Britain who are especially affected by the change in question are inclined unduly to magnify its effects. After all, the cost of new construction accounts for only a comparatively small part of the total which Great Britain spends on her navy. Repairs and maintenance work will still remain to be done.

We are not unmindful of the fact that, in these days, industry is organized on so large a scale, and is so highly specialized, that it is not very easy to change from one class of work to another. But, while a certain amount of dislocation may be, and is, inevitable in British dockyards and steel-making centres, one needs to take the long, and not the short, view of this big question of limitation of armaments. For the time being, the reduction of armaments may mean less employment for a considerable number of works. For the time being, it may mean less business for a certain class of employers. But, in the long run, it will mean more employment and more business. Employers and employees alike who have been accustomed to concentrate on the construction of battleships will concentrate on the construction of something else. Instead of making something which may never be needed, and which, in any event, added nothing to the wealth of the country, they will be free to make useful things which will increase the country's wealth.

Furthermore, regard must be had to the fact that, unless Great Britain can effect some substantial reduction in the cost of her fighting services, increased taxation in next year's budget looms ahead of her. Nor can there be any question but that it is her present heavy taxation which is one of the most formidable causes of the industrial depression from which she is suffering so acutely. We admit that it is difficult for employers and employees who are directly affected to pay to these considerations the regard which is their due. But, nevertheless, we are convinced that the proposed course which, for the moment, may seem to operate hardly on individuals, will turn out to be for the ultimate benefit of the community.

RESEARCH AND THE STEEL INDUSTRY.

During the past few years there has been much said and written on the subject of research in relation to industry. There has been in Canada an attempt made to establish Bureaus of Research and this attempt brought out many expressions of opinion. There was general agreement that the encouragement of research is in the interests of industry, but the plans proposed for the stimulation of activity in research did not get the expected support. Many arguments were advanced in support of the proposal to establish Research Bureaus and the importance of research in industry was more widely recognized as a result of the discussions; but the proposed organization of researches did not get very far.

Research has played a very important part in the advances made in the metallurgy of iron and steel from the earliest stages of the industry. Those engaged in the industry did not need to be enlightened on that subject. Since, however, it was proposed to use public funds to encourage research it was necessary to arouse public interest in the matter and to show the public that increased activity in research was sufficiently a matter of public interest to warrant public expenditure to establish research bureaus. This educational campaign did not have the desired result.

One reason for the lack of public interest in the matter was probably the failure to get expressions of opinion from men actively engaged in the industries. The views of researchers and college professors were freely given and some business men worked in favor of the establishment of Government Research Bureaus. There was however, in many instances a notable lack of appreciation of the needs of the industries which it was proposed to benefit by the organization of research works.

There has just been published a paper read before a meeting of the National Research Council in New York, by a man who graduated from the laboratory into the chief executive post in his company. He writes on "Research in the Steel Industry" with a very definite knowledge of what is meant by research and with a proper understanding of the value of research in the industry. He makes it clear that research must, from the standpoint of the industry, be considered like other aspects of the business, with a clear view to the increasing the profits of the business. Starting frankly with this in mind he states:

"The research department of a steel company may function in many ways to contribute its part to this success: 1. It may endeavor to improve the product, which leads to greater demand, larger output, greater ability to meet competition, and the ability to command higher prices. 2. It may direct its efforts towards lowering costs (*a*) by finding cheaper but satisfactory raw materials; (*b*) by improving old processes to increase yield or decrease labor, or both; (*c*) by developing new products and finding uses for byproducts; (*d*) by finding new uses for existing products; and (*e*) by improving operating conditions in the plant not directly connected with the product itself, such as effecting savings in water, fuel, lubrication and electricity, and by improving the working cycles, material movements and power conditions. All of these result in public good and bring their reward because they lead to better goods, cheaper goods, or the better supplying of the public needs.

"It is not my judgment that the pure science of the steel industry should be left to the college laboratory and the Bureau of Standards, nor do I believe the practical problems of the industry should be turned over to these institutions. Toy melting furnaces without experienced melters and toy rolling mills without trained rollers do not appeal to me. The industry should assume all of its practical problems and most of its theoretical ones, leaving the theoretical and impracticable for thesis subjects, and then the graduate will not have so

much to forget when he enters a plant. Most of my university training was in the line of organic chemistry, and I do not regret one minute of it. My efforts to visualize molecular changes in carbon compounds have led me to visualize the idiosyncrasies of the carbon conditions in steel, and when I see steel in the course of manufacture or heat treatment I have a mental iron-carbon diagram pasted right on the piece like a tool-steel label.

"Research methods in the steel industry have been much extended during recent years. Indeed, the general adoption of routine chemical analysis, physical testing, the microscope and pyrometer are all within the memory of men still active in the industry. Fatigue testing, shock and repetitive impact tests, dilation, conductivity, and magnetic analysis as research methods in quite general use are developments of this century; we may almost say, of the present decade. No one of these tests tells us all we would like to know about steel. They are mutually supplementary; the more we have of them, the better; and with all of them in use in the case of steel that fails in service it is sometimes very difficult to answer the question. Why did it fail?"

The view that the industry should assume its practical problems is evidently a widely accepted view. When research is sufficiently important to be considered a practical problem it is undertaken like any other branch of the business.

"DIRECT STEEL."

The subject of "Direct Steel" has formed the basis of much speculation and research for many years—with very little to show for it either in practical results or in constructive theory. A very interesting and exhaustive paper on the Direct Process for Steel Manufacture and the possibility of using oil, lignites and other fuels was read, last month, at the twentieth general meeting of the American Iron and Steel Institute in New York by Mr. A. E. Bourcoud, consulting engineer, of New York City. As Mr. Bourcoud suggests, it is possible that the fact that there is so little to show for so much speculation in research may be—at any rate, in part—due to the problem not having been approached in the right way by investigators, or to their failure to take advantage of the data and scientific facts to be deduced from blast furnace practice. For, as he points out, the problem itself is not more difficult of solution than others of a strictly chemical or metallurgical character which have been solved during the same period of time as that in which "Direct Steel" has been an object of interest and research.

In the paper in question, Mr. Bourcoud has outlined the theoretical requirements of the direct steel process and has indicated the possibilities of a successful solution on an industrial scale. The conclusions at which he arrives may be summarized as follows:

(1) That the gasification of atomized oil and powdered coal of any kind presents great possibilities for generating economically in large industrial units, very powerful reducing gases, emerging from the producer at a sufficiently high temperature for immediate use in reductive operations.

(2) That the economic reduction of iron ore by a current of gases with the employment of working agencies based on the continuous impingement of the gases on the ore, shows great possibilities of large-scale operations, delivering continuously spongy iron, at high temperature, ready to be melted in furnaces of standard types.

(3) That the combined economic efficiency of both operations would make possible the establishment of the iron and steel industry in places where present methods have little chance to work commercially owing to the lack of coking coals, as is the case in California, Texas, Black Sea, and other localities possessing oil; Brazil and Italy, with lignites, and many more with good non-coking coals, like France.

(4) That even in the actual steel district, the employment of powdered coking coal in the combined suggestion can show favorable economic results competitively with our present routine.

The paper, which is in pamphlet form, offers suggestions which are intended to be conducive to the commercial realization of the so-called direct process for steel-making from what appears to be a new point of view. The fact that hitherto none of the experiments hitherto attempted has been fully successful as regards the application of the direct steel principle on a commercial scale gives additional point to the theories and arguments on which Mr. Bourcoud bases his conclusions.

ACCIDENT PREVENTION.

A very informative and suggestive article on Accident Prevention at Gary appears in The Algoman, the house organ of the Algoma Steel Corporation. The article in question is by Major Kenneth M. Burke, head of the Safety department of the Illinois Steel Company. Apart from its own intrinsic value, it is of special interest inasmuch as many of the features of the Gary system—notably the shop committee system and the plant committee system — are to be introduced immediately into the Algoma Steel Corporation's own mills, as supplementary to its own existing accident prevention system.

As Major Burke points out, the first essential in accident prevention is to know how an accident occurs, in order to know what to do to prevent another accident of a similar nature. This analysis, he considers, leads directly to a natural division of causes into two general classes — accidents which are preventable, and those which are non-preventable — although, as he rightly points out, all accidents are, in the broad sense preventable. This being so, the direction for effort to take is towards the entire elimination of all preventable accidents, and towards the reduction of the number of so-called non-preventable accidents.

Preventable accidents, says Major Burke, divide into two general classifications. First, those that are due to a lack of care on the part of the employer. Second, those that are due to carelessness on the part of the workmen. Accidents that may be said to result from neglect on the part of the employer may be from one of the following reasons:

1. Failure to provide proper tools, appliances or a safe place to work.

2. Failure to provide safety devices.

3. Failure of someone in authority to use proper tools or appliances, provided, or his improper act or selection of improper methods of doing the work.

4. Failure to instruct men as to the safe methods of doing work.

In order to prevent these, it is evident that the employer must provide and maintain proper working conditions and must provide and maintain proper and efficient safeguards on machines and appliances. He must also require on the part of those in authority a thorough and constant observation of the necessity for conducting work in a proper and safe way and require them to instruct and warn their men of dangers incident to their work.

Major Burke attaches importance to what can be done in the way of education by well directed publicity methods. For example, at Gary a sign at the employment office reads: "Notice to men seeking employment. Unless you are willing to be careful to avoid injury to yourself and fellow-workmen, do not ask for employment. We do not want careless men in our employ." Then, too, the screen is inpressed into service to emphasize the necessity of safety devices, safety committees, etc., and the wisdom of safety precepts.

But Major Burke regards the safety committee itself as the most important means of preventing accidents. Here he says that, "in order to obtain effective results, the key-note must be enthusiasm. No man can be enthusiastic in any work unless he believes it is right. There must be no doubt of it in his mind. Therefore the committee-man must be impressed with the frankness and sincerity of the management." Emphasis is laid on the importance of getting the right man as chairman of the committee, and on the holding of little safety meetings, among groups of workmen. The safety committee system for the plant, and the safety committee system for the various departments have, it is plain, produced excellent results. We have no doubt, that the Algoma Steel Corporation is doing wisely in deciding on their incorporation into its non accident prevention system.

MR. HANNA ON THE C. N. R.

Mr. D. B. Hanna, President of the Canadian National Railways, denies that he stated at Kitchener on Thursday that the day of deficits was past, as reported in Press despatches from that city.

"I pointed out," he said, "that while we had a small net in August, followed by a better result in September, and net earnings of more than a million dollars in October, and expected some net earnings in November, and even a small margin to the good in December — notwithstanding the reduced rates — we would hardly expect to avoid a little setback in January and February, when weather and other conditions make it very difficult to make ends meet, and when, particularly in view of the serious unemployment situation, we were not cutting our maintenance forces as drastically as we would feel justified in doing if other employment were available.

"Also, as to the Canadian Government Merchant Marine, I said that, while we had made good showing in 1919 with the good ships we had in service, 1920's operations were not so good, although the returns provided more than half a million dollars for interest after taking care of operating expenses and depreciation, but as to the results this year, the matter was 'in the lap of the gods.'

"As everyone knows, the conditions surrounding ocean steamship services are exceptionally bad, and we feel we are to be congratulated in having been able to secure enough business to keep the ships in service, which is better than tying them up. The returns will not be available for some time yet, but all steamship companies have had losses this year, and very heavy ones."

MONTREAL AND TORONTO CONDITIONS.

The Canadian Machinery and Manufacturing News says:

Montreal reports very little activity in any line. The rail mills are rapidly completing their orders, and there are no more in sight. The steel demand is light and the conditions prevailing for the past few weeks have not altered. Machine tools are hardly moving, but portable tools seem to be in fair demand. Nonferrous metal are stronger, copper being especially active.

Toronto reports a spotty market. Metals are quite a bit stronger, but this is the only bright spot. Copper, tin, and lead are the three stronger items. The steel market reports only fair demand, while machine tools are very quiet. The supply market is also weak, repair parts being the only thing in demand.

U. S. STEEL UNFILLED ORDERS 4,250,542 TONS ON NOVEMBER 30.

Operations of the Steel Corporation during November, according to a despach from New York, averaged about 52 per cent of capacity, the highest point that has been attained since production turned upwards last summer. It is estimated that incoming business in November amounted to about 26,500 tons daily, compared with 13,000 tons in October. In September, an increase of nearly 30,000 tons in forward business was placed on the Corporation's books, the only exception to the steady downward trend in unfilled tonnage this year.

The peak of unfilled tonnage was reached in April, 1917, when bookings amounted to 12,183,083. There was virtually a steady decline until May, 1919, when bookings increased, ultimately advancing to 11,118,468 in July 1920. Another decline set in, which continued until September of this year.

The monthly tonnage report of the United States Steel Corporation, made public today, showed 4,250,542 tons of unfilled orders on hand November 30. This is a decrease from October's unfilled orders, which totalled 4,286,829 tons.

Effect of Sulphur and Oxides in Ordnance Steel

By William J. Priestley*, South Charleston, W. Va.

In the manufacture of gun forgings and other steel parts that in service are subject to sudden high stresses and shocks, it is most desirable to use steel possessing the greatest toughness and ductility possible without the sacrifice of strength. In order to obtain this condition, it is necessary to procure steel that shows the highest possible elongation and reduction of area without lowering the tensile strength and elastic limit. Proper heat treatment of the steel can control this condition within certain limits. When heat treatment has failed to produce the desired results, metallurgists have used steels containing molybdenum, zirconium, vanadium, chromium, tungsten, etc.

The purpose of this paper is to describe a method by which these desired physical properties may be procured — by the elimination of certain impurities that inherently exist in steel made by the open-hearth process, and without the use of expensive alloys.

In the manufacture of gun forgings, a certain elastic limit is fixed by the designer, and the walls of the gun are made of the proper thickness, allowing a suitable factor of safety for the high stresses and sudden shocks that occur during gun firing. The elastic strength of the gun is about 1.4 times the stress set up at any point along the bore of the gun during firing with the maximum powder charge.

As the stresses set up in the walls of the gun during firing are mostly "tangential," all physical tests are taken in this direction. Due to the length of the forgings, these tangential test bars are always taken at right angles and transverse to the direction of flow of the metal in forging. Furthermore, test bars taken across the grain of the metal will more frequently expose defects and foreign inclusions in the steel than will bars taken in the direction of flow of the metal in forging. Impurities in the steel will also be more readily detected by transverse test bars.

With a fixed tensile strength and elastic limit, a steel with higher elongation and reduction of area is more desirable for service where sudden stresses and great shocks are encountered. The high elongation denotes ductility and the high reduction of area denotes toughness; for the purposes just mentioned, these properties are preferable to a higher tensile strength and higher elastic limit with a lower elongation and lower reduction of area.

Effects of Phosphorus.

It would be difficult to draw any comparison between the open-hearth and electric steel in regard to the phosphorus content. This element is in solid solution with the iron as a phosphide and the percentages are too small in both the open-hearth and the electric steel to denote any difference even with a microscope. The lower phosphorus in the electric steel might have a slight effect on the elongation, due to producing a somewhat shaller grain and decreased brittleness in the steel.

Effect of Sulfur.

It has been stated by a recognized authority on the manufacture of steel that "the effect of sulfur on the cold property of steel has not been accurately determined but it is certain that it is unimportant. In common practice, the content varies from 0.02 to 0.10 per cent, and within these limits, it has no appreciable influence on the elastic ratio and the elongation or the reduction of area." This statement probably relates to commercial steels tested longitudinally. In this case the sulfur, in the form of manganese sulfide, has been drawn out into thin shreds in the direction of forging or rolling and is not so easily noticed in the results of longitudinal test bars as it would be in the case of transverse bars. With the overbalancing amount of manganese present in all the steels referred to in this article, probably no iron sulfide is present in the steel for none of the ingots showed any signs of tearing during forging. Steel containing iron sulfide is known to tear in forging and is termed "hot short" by steelworkers. Manganese sulfide has been described as being present in the ingot in the form of small globules between the grains of the metal. Having about the same fusing point as the metal, these inclusions become equally plastic when the ingot is heated for forging and are drawn out into long thin shreds — just as slag is drawn out in wrought iron. If, however, the amount of manganese sulfide present is not enough to form these globules, these shreds will not be developed in forging and transverse test bars will show as good results in elongation and contraction as longitudinal bars.

Effect of Oxygen.

There is nothing in the usual chemical analysis to show how much oxygen is present in steel. It exists in small amounts in even the best steel and has bad results. In large amounts, it produces tearing during forging or rolling, and when cold is brittle under shock. If present in steel, it is probably in the form of iron and manganese oxides and silicates. Oxygen is most prevalent in basic open-hearth steel. Where non-metallic enclosures are great enough to analyze, they have been reported to show the following composition: SiO_2, 50 per cent; MnO, 30 to 40 per cent; Al_2O_3, 7 to 18 per cent; FeO, trace. In the acid open-hearth furnace a more effective reaction beween the slag and the steel tends to deoxidize the steel more thoroughly. This cannot be done completely on account of the air present in the acid open-hearth furnace.

A condition exists in the basic electric furnace which cannot exist in the basic or the acid open-hearth furnaces. With a reducing atmosphere in the furnace, it is possible to form a calcium carbide slag free from metallic oxides; with constant rabbling of the bath, any oxides in the steel will rise to the slag, where they are reduced by the carbon present. The iron and manganese are returned to the bath, and the resulting carbon monoxide is liberated to the atmosphere of the furnace. Unless the slag and bath are free from oxygen, it would be impossible to maintain a carbide slag; and unless the slag and bath were thoroughly deoxidized, it would be impossible to retain the sulfur in the slag as calcium sulfide.

Hence, the conditions that bring about the elimination

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[*The following is an abstract of a paper to be presented at the New York Meeting of the American Institute of Mining and Metallurgical Engineers, February 1922. Ed. I and S. of C.*]

of sulfur from the steel guarantee that oxides and other non-metallic impurities have also been eliminated. This is demonstrated in the case of forgings made by the electric refining process in different steel plants, the test bars of steels containing the higher sulfur, show no better results than the forgings made by the acid open-hearth process.

Manufacture of Steel at Naval Ordnance Plant.

It is evident that the presence of sulfur, oxides, and other non-metallic enclosures are detrimental to the ductility and toughness of steel. Where the best quality of steel is required, it is necessary to keep these impurities to a minimum. The basic open-hearth furnace eliminates the phosphorus but only slightly reduces the sulfur; the oxides must be eliminated by the addition of deoxidizers, such as ferromanganese, ferrosilicon, aluminium, etc., which are sometimes added to the open-hearth furnace and rabbled after the air is shut off but more frequently are added to the metal in the ladle. If added in the ladle, the reactions are incomplete and the products of combustion remain suspended in the steel, forming harmful non-metallic inclusions. Gun forgings and other ordnance material, where transverse tests are required, have never been successfully made from basic open-hearth steel. The bars generally fail in elongation and reduction of area tests, because of the presence of these inclusions. They generally break with a laminated and woody fracture.

The acid open-hearth furnace is better for making steel free from oxides and non-metallic impurities, and ordnance forgings have been obtained from acid open-hearth steel. While neither phosphorus nor sulfur can be eliminated in this furnace, the amount of these impurities may be kept down by the selection of high-grade scrap and pig iron. The oxides may be largely

The pig iron has the following approximate analysis: Carbon 3.50 to 4.00 per cent., manganese 0.95 per cent., silicon 0.65 per cent., phosphorus 0.15 per cent. and sulfur 0.04 to 0.05 per cent. The crop ends are usually low in phosphorus and sulfur, being eliminated by the effective reaction between the slag and the steel.

The method of making steel at the U. S. Naval Ordnance Plant aims for the elimination of phosphorus, sulfur and oxides. The metallic charge of the open-hearth furnace consists of 40 per cent basic pig iron and 60 per cent miscellaneous scrap, including turnings, crop ends, etc., up to 8 per cent of limestone is added with the charge and sufficient ore to lower the carbon to approximately 0.20 to 0.25 per cent, which is slightly below the amount required in the finished steel.

the discard from ingots made at this plant by the electric refining process. The miscellaneous scrap, consisting of boiler plate, punchings, and turnings, average approximately 0.04 to 0.05 per cent phosphorous and sulfur.

The average analysis of the slag taken from the open-hearth furnace on nineteen consecutive heats just before tapping is as follows: SiO_2 15.43 per cent., FeO 19.27 per cent., Al_2O_3 3.66 per cent., MnO8.02 per cent., CaO 45.02 per cent., MgO 6·37 per cent., P_2O_5 1.80 per cent., S. 0.031 per cent.

The average analysis of the steel prior to tapping these same heats was as follows: Carbon 0.23 per cent., manganese 0.26 per cent., silicon 0.010 per cent., phosphorus 0.007 per cent., sulfur 0·015 per cent., nickel 0.66 per cent., chromium 0.00 per cent. After it is tapped from the open-hearth furnace into a 75-ton ladle, the steel is teemed through a 2½ in. nozzle into two 40-ton basic electric furnaces for deoxidizing and finishing. Usually 2 lb. of 50 per cent. ferr-silicon and 3 oz. of aluminum for every ton of steel tapped from the open hearth are added to the ladle, to take up any oxygen present, which might lower the carbon content while the steel was in the ladle.

An average analysis of the slag left in the ladle from the nineteen heats, after teeming into the 40-ton furnace was as follows: SiO_2 17.27 per cent., FeO 18·32 per cent., Al_2O^3 5.75 per cent., MnO 7.84 per cent., CaO 42.79 per cent., MgO 8.15 per cent., P_2O_5 1.65 per cent., S 0.028 per cent.

The average analysis of the metal as teemed into the electric furnaces from the open hearth on the same heats was as follows: carbon 0.20 per cent., manganese 0.23 per cent., silicon 0.037 per cent., phosphorus, 0.007 per cent., sulfur 0.016 per cent., nickel 0.67 per cent., chromium 0.00 per cent. Both the furnace and the ladle slags show a slight decrease in silica and alumina, which may be caused by the addition of the ferro-silicon and aluminum into the ladle. Some of these same elements may have been washed from the sides of the ladle and floated up into the slag. A comparison of the steel analysis will show that the silicon increased slightly; also, that there was a slight drop in carbon and manganese while the steel was in the ladle. The average phosphorus content of the charge into the open hearth was about 0.08 per cent., because of the comparatively low phosphorus in the crop ends.

Conclusions.

The manufacture of ordnance forgings from electric steel is not an innovation. It was tried, during the war, in a number of plants. Some of these plants were not as successful as others, probably because the managers were not sufficiently experienced in the many other phases of manufacture necessary in the making of ordnance forgings.

Steel made in an electric furnace will not be of the best quality unless all operations and reactions are performed completely and satisfactorily. Electric steel with its greater freedom from oxides and non-metallic impurities is more uniform, more homogenous, and more dense than ordinary open-hearth steel, and if it is cast at too high a temperature or chilled beyond a certain point in the mold, incipient cracks will develop. These minute cracks are radial and are most frequently found near the center of the ingot or forging. Numerous electric-steel plants working on ordnance material, during the war, were troubled with these defects, which from their physical appearance in test bars were called "snow flakes."

A diversity of opinion has always existed between the leading ordnance steel plants regarding the method of teeming steel into the molds. Some have consistently adhered to bottom pouring while others have claimed better results from top pouring direct, or through funnels or boxes. The method apparently makes little difference if the steel is placed in the mold at the proper temperature and has been properly cleansed before teeming. Top pouring direct obviates the danger of getting runner brick into the ingot, which frequently occurs in the case of bottom pouring. It also obviates the danger of sand washing into the molds with the metal from the funnel or box. Bottom pouring will give a better surface on the ingot and for some purposes may be more desirable.

Chromium Steels and Irons

In a paper read before the Institution of Automobile Engineers and printed in the "Transactions" of the Institution, Dr. Leslie Aitchison set forth some useful data regardng the properties of steels with varying percentages of chromium in their composition. In discussing his subject the author dwelt more particularly upon its relation to the automobile industry, but a great deal of the matter contained in his paper is of interest to the steel industry generally.

Speaking of the extended use of alloy steels for general engineering purposes, the author remarked that undoubtedly, in the first instance, engineers were attracted to the use of alloy steels because of the high strength which could be obtained from them, but after a fairly long and sometimes bitter experience it was probable that the average engineer was not so greatly enamoured of very high tensile materials as he once was, and that he had come to realize in very many circumstances the paradoxical truth that the stronger the steel the weaker was the part made from it. Nevertheless, alloy steels were probably even in greater favor now than they were when their most obvious claim to respect was the high strength which they would provide. Probably this was due to the fact that it was possible to obtain an alloy steel of a given tensile strength which was very much more tough than the carbon steels of the same tensile strength. For many purposes toughness was now regarded as of greater importance than strength, and it was because the carbon steels were so frequently deficient in toughness that the alloy steels had their present vogue. This advantage was so great that the alloy steels were never likely to be ousted from the position which they now held.

A further notable advantage which alloy steels present when compared with carbon steels (continued the author) is found in the case with which they can be hardened. Engineering details of even moderately large dimensions are exceedingly difficult to harden when made in carbon steel, due to the "mass effect" in hardening. In works practice this means the difference between quenching a part in water or in oil, or even hardening it by cooling in air. Naturally, it is usually preferable to be able to cool a part fairly slowly for the purpose of hardening, as the slower a part may be quenched in order to harden it, the less danger there is of inefficient hardening and of irregular results, not to mention the danger of serious distortion. The three main advantages, therefore, which can be presented by the alloy steels as against the carbon steels are:—(1) High tensile strength; (2) high toughness; (3) ease in hardening and homegencity in the resulting product. There are some accompanying disadvantages. In the first place, alloy steels are generally more costly than carbon steels, though this does not apply to every class of carbon steel or to every class of alloy steel. Secondly, in consequence of the fact that alloy steels will harden much more easily than carbon steels, i.e., they will harden when cooled more slowly, it is found that they are more prone to the development of surface defects, which are produced during cooling either from the operations of casting, or forging, or drop forging, or even during heat-treatment. The higher tensile strength found in a large proportion of the alloy steels also renders them more diffucult to machine, and this naturally considerably affects their economic value in engineering.

Almost all of the nickel-chromium steels (which perhaps, represent the most widely employed class of alloy steel) harden to a notable degree when cooled in air, sufficient at any rate to cause difficulty in consequence of the hardening of the surface and the production of flaws. These steels always require to be softened to give a strength which is consistent with reasonably easy machining. Stainlessness, or freedom from corrosion, is definitely an attribute of the chromium steels, and no other class of steel can present the same advantages.

The most obviously interesting group of the special chromium steels and irons is that of the "stainless" materials. It is fairly generally known that these metals contain round about 12 per cent. of chromium. and it is known that they do not corrode or rust when immersed in vinegar or the like. The mechanical properties of these materials are not so widely appreciated. It is also not so thoroughly understood that the mechanical properties of "stainless" materials are naturally affected by he proportions of carbon which they contain. If the proportion of carbon is too high, the "stainless" properties may actually disappear, but that is the least interesting feature. The mechanical properties are distinctly altered and many other accompanying characteristics changed by decreasing the proportion of carbon below that usually found in stainless steel. The lower carbon materials are more easy to work in the forge and in the mill, whilst the relatively low-hardening properties which they display render them less prone to the development of surface defects during the operations of casting and hot-working.

The comparative ease with which the lower carbon forms of "stainless iron" can be worked, renders it particularly suitable for the production of sheet, strip, wire, etc., as well as for the manufacture of comparatively intricate drop forgings. The tensile properties of the irons are, in general, lower than those of the better known stainless steels. When it is also remembered that this class of material should be purchasable at a lower price than that of the better known stainless steel, the comparative value of the metal becomes quite high. In Table III. of the chemical composition of several different materials containing a stainless proportion of chromium are set out.—(Iron and Coal Trades Review).

GRINDLE FUEL EQUIPMENT COMPANY.

Whiting Corporation, Harvey, Ill., (Chicago suburb), has purchased a controlling interest in the Grindle Fuel Equipment Co., manufacturers of Complete Powdered Coal Plants for use in connection with malleable furnaces, annealing ovens, steam boilers, billet heating and various other types of furnaces The Grindle Fuel Equipment Co. has moved its offices to Harvey, Ill., and will continue its business under the same name Whitinf Corporation. will manufacture Fuel Equipment. The following officers have been elected: President, B. H. Whiting; Secretary and Treasurer, T. S. Hammond; Vice-President and General Manager, A. J. Grindle; Board of Directors: J. H. Whiting, B. H. Whiting, T. S. Hammond, A. J. Grindle, R. H. Bourne, N. S. Lawrence, A. H. McDougall.

Rolling and Forging Practice

British and Belgian Methods Compared.

By ROLAND H. BRIGGS.

A feature of the reconstruction of Belgium steel-works is the exceedingly modern equipment with which they are being furnished and the very up-to-date meahods and organization of the steel mills, which conduces in a large degree to great output, standardisation and cheap production. No Canadian who has seen the devastation of Flanders will regret that some advantage should eventually accrue to the people of Belgium out of the sufferings of the War, but it is of importance nevertheless, that steel manufacturers in countries in trade competition with Belgium should realise how severe that competition is likely to be.

Owing to the complete devastation of the steel-works by the Germans, or the stripping of them of all their plant, the Belgium steel manufacturers have been able to consider the matter from the point of view of total reconstruction, with the capital provided, and the equipment of the new mills may now be regarded as second to none in the World. It is clear that this will not make it easy for those whose plant has been built up througt a period of years, and who cannot afford to scrap everything and start with everything new.

Britain is one of the countries which will feel this competition most keenly, and a service has been rendered by Mr. L. G. Harris, who described with great directness and detail the present methods of guide rolling and general forge practice in Belgium and Britain, in a paper which he read before the Staffordshire Iron and Steel Institute on November 19th, 1921.

Mr. Harris investigated stel-works conditions in Belgium last year and speaks with first-hand knowledge of his subject. He describes in detail the equipment and organization of five of the steel-works which he visited.

In the first works there were seven puddling or busling furnaces in the forge department, working a mixture of pig iron and scrap. The furnaces were of the ordinary type, but with forced draught supplied from a 20 B.H.P. centrifugal blower with 18 in. outlet. The balled up sponge iron was carried to the steam hammer on a hand trolley, and after being shingled was rolled on the forge train into 6½ in. by ½ in. bar. The bars were cut to the lengths required when cold.

The piles were of the faggoted box type, made up with 6½ in. by ½ in. bars at the top and bottom, with miscellaneous wrought iron and steel scrap piled between the bars. The piles are pressed tightly down by hand screws press and bound together with two pieces of 3/16 in. hot wire. The piles are then weighed and stocked on a trolley for conveyance to the mill.

The mill furnaces consisted of four combination gas furnaces and producers, one of which is kept in reserve. The producers were of the water-sealed type, fired from above through hoppers, and the capacity of the three furnaces in operation was sufficient to give a continuous supply of piles and billets to the mill, which was a steamdriven 10 inch guide mill, with a direct drive on to three high breaking down rolls, at about 14 to 16 inch centres, and running at a speed of 82 r.p.m.

The guide train washelt driven at 250 r.p.m. and consisted of 6 pairs of stands, 5 in operation, rolling 5/8 in. round iron from 6½ in. faggoted box piles. A hand operated runway carried the piles from the furnace to the breaking down rolls.

Twenty passes were required to roll the 6½ in. pile down to 5/8 in. round, 9 passes in the breaking down rolls, 3 in the roughing rolls, 4 on the 2nd. stands, 2 on the third stands, one on the ovals and one on the finishing rolls. The finished bars, about 100 feet long, were delivered at 10 feet per second. Owing to shortage of space, the bars run into subways under the floorplates at each end of the mill. A clear space of 20 feet from the rools and cooling bank of 110 feet available. The average weekly output of all sizes was given as about 450 tons, or 28 tons per 8 hour shift.

The bars were cut cold by small electrically driven shears, piled up to give a given weight on a weighing machine, when an electric crane picked up the pile and stacked it away in a given pen, with the details of customer, weight and destination recorded.

The second works described by Mr. Harris consisted of a large blast furnace, with steel smeltings and roll-plant. The plant had been destroyed by the Germans, but the whole works was being reconstructed. A new 10 in. guide mill was being erected, generally similar to the one described in the first works, but electrically driven, and arranged to roll steel bars only. The furnace attached was of the gas-fired continuous type.

In the third works iron was being produced from faggoted box piles. A 10 in. steam driven guide mill was used and the average output was about 450 tons per week on all sizes.

The fourth works visited was an iron-producing plant, with 6 or 7 busling furnaces working a mixture of scrap and swarfe. A time saving arrangement for cleaning the grate-bars in these furnaces consisted of the slotted bearers for the bars being hinged on one side and controlled by a balanced lever. For cleaning purposes, temporary bars are inserted 6 inches above the level of the permanent bars to retain the fire in the furnace, and the balance lever is raised so that the grate bars are brought to a horizontal position, the clinker and ashes falling into the ashpit. The grate bars are then brought back to their original position and the temporary bars withdrawn, the whole operation taking very much less time than older methods.

The mill was a 10-inch steam driven guide mill, with a direct drive on the three high breaking down rolls, and a belt driven guide train with six pairs of stands five of which were in operation. The work consisted of rolling ¾ in. round steel from 3 in. billets, the finished bars being about 90 to 100 feet long, and the output about 35 to 40 tons per 8-hour shift. Female labour is used for piling in this works, which tends to further reduce production costs.

In the firth works there was the usual 10 in. guide mill, and a particularly interesting mechanical cooling and conveying bank. The finished bar, at it left the rolls, was carried on live rollers between a channel, and at a given point was mechanically tipped on to the cooling bank. The motor driven bank had a oscillating motion which has the double result of straightening the bars and conveying them to further live rollers, which carry the bars to the shears for cropping and

cutting into the desired lengths. The bank could deal with a large output and only one man was required to look after the bank and both sets of live rollers.

Other works were visited and one of the most noticeable things throughout the tour was the number of new guide mills which are being installed, the similarity of these mills in general design, which includes the tandem principle, 16 in. centres, direct driven breaking down rolls and belt or rope driven finishing train, all of the high speed type.

Not only the new plant of the Belgium steelworks, but also their manufacturing practices, are worthy of close attention. In producing ordinary common or crown bars for the nut and bolt trade, the general practice in Britain is make the pile entirely from puddled bars, or with about 30 per cent scrap or bushelled bars. The Belgium faggoted box piles, on the other hand, made with puddled bars at the top and bottom and mixed bought scrap inside, have a ratio of about 20 per cent puddled bars and 80 per cent scrap. A comparison of the prices of material in the piled state as described above appears to give the Belgium a considerable advantage at this initial stage of steel production.

The output of the average guide mill in the Black Country in Britain is about 10 to 12 tons of 5/8 in. round iron per 8 hour shift, or 14 to 15 tons of ¾ in. round iron, with two coal fired furnaces or one large gas fired reversing furnace. The Belgium mill at the first works described had an output of 28 to 30 tons of 5/8 in. round, but was furnished with three gas furnaces. The extra output fully justifies the extra furnaces, and the overhead charges are greatly reduced.

Puddling methods are similar in Belgium and Britain, except that in the former country it is more general to throw a large amount of small heavy scrap in at the dropping stage, which lowers the cost of the product. The fuel used in Belgium, except for cleaning fires and lighting up, was exceedingly fine slack, a greatly inferior fuel to that used in Berlin. The cheaper methods used in the Belgian system of piling has been referred to above, and the fact that their production of nut and bolt qualities from such material does not result in too high a proportion of defective bars appears to be due to the higher speeds of rolling used. The piling presses used are very simple and inexpensive.

The Belgian heating furnaces are gas furnaces, with producer and furnace combined. Some of the furnaces are of the grate bar type, with steam jets under the bars, others of the more modern water sealed class. The number of furnaces to each mill, especially important in relation to the output of iron rolling plants, was remarkable. The additional reserve furnace may seem a luxury, but probably soon pays for itself in maintained output and reduced cost of repairs, which need not be done by overtime or Sunday labour. Regular furnace repairs also tends to increased furnace life.

The question of correct furnace capacity is much more difficult to decide in mills which are rolling both steel and iron. In Belgium it seems to be more general to lay out the mills either for all one or all the other. Thus cost of production is brought down to the absolute minimum, the furnace plant being designed for one object alone, and it is very difficult for a mill rolling both steel and iron, and using two coal fired furnaces, or one reversing gas furnace, economically to compete.

The main features of the Belgian rolling system are excellent. They include large 16 in. breaking down rolls, direct driven from an engine or motor, at a speed of about 82 r.p.m. The principle of breaking-down rolls is most satisfactory, the speed and large diameter of the rolls quickly billeting the pile down ready to be passed on to the roughing rolls. This results in sound finished bar from the faggoted piles without reheating. The breaking down rolls are one of the principal factors in high outputs and cheap production.

The finishing trains are driven from a large flywheel on the main shaft to a small pulley which also acts as a flywheel. The drive is usually 25 to 30 feet long and about 3 to 1 ratio. This drive is free from shocks and easy to alter by changing the smaller pulley for one of a different diameter. The speed of the finishing train will be about 245 to 250 r.p.m. in Belgium compared with only about 170 to 180 in Britain. The barrel of the oval and finishing rolls in Belgium is much larger than is usual in Britain, it being possible to get away as many as ten finishing sizes in one pair of rolls, which saves time in roll changing and thus increases output.

The methodical organization for weighing up and stocking finished bars in Belgium calls for praise. In the first works described near the beginning of this article the warehouse was about 100 yards long by 18 yards wide, with an overhead travelling crane and a branch railway track across the end of the warehouse. The finished bars are cropped and cut by the shears, are weighed, and deposited by the crane in pens holding up to 25 tons. When forwarding instructions are received, the bars are lifted from the pens by the crane and deposited in the railway cars.

Belgium is thus not only equipped with the most modern appliances, she is also working on the most approved modern methods, and will in consequence prove a keen competitor of all steel and iron producing countries in the future. The details which Mr. Harris has made available will however prove helpful to other producers, who will be able to compare and if necessary revise their own methods in so far as they appear to need improvement.

EXIDE BATTERIES OF CANADA, LTD.

Some Account of a Company Which is Playing, and is Destined Increasingly to Play, an Important Part in the Industrial and Social Life of the Dominion.

By A. R. R. JONES.

The plant of Exide Batteries of Canada, Ltd., is located at 153 Dufferin Street, Toronto, adjacent to the western entrance to the grounds of the Canadian National Exhibition. The building was bought and remodelled in the fall of last year by the Company named which commenced its operations therein in February of this year. The lot on which it stands is 259 feet wide by 301 feet long, and the buildings themselves are 185 feet in width and 236 feet in length. One of these three buildings contains the offices, small stores and shipping room. Another is devoted to the charging separator treatment, casting and assembling shops. The third contains the acid storage department, the store room and dressing and lunch rooms. As regards the dressing rooms, it should be mentioned that these are capitally equipped with showers, baths, etc. In fact, the plant, as a whole, when visited by the writer the other day, presented an admirable appearance. It is splendidly designed for efficiency of operation and it affords every facility for manufacturing under the best modern factory conditions.

Officers and Products.

The officers of Exide Batteries of Canada, Ltd., are as follows: Mr. Herbert Lloyd, president and general manager; Mr. C. W. Woodward, vice-president; Mr. Walter G. Henderson, secretary-treasurer; and Mr. A. N. Bentley, manager.

The products of the plant are storage batteries for automobile starting, lighting and ignition systems and batteries for farm, light and power plants. This Company supplies the batteries for all the Ford cars that are made in Canada and also for all the McLaughlin cars that are made in Canada. It also acts as the distributor in Canada of the products of its parent company in the United States, the Electric Storage Battery Company, of Philadelphia. Of this parent company, Mr. Herbert Lloyd, the president and general manager of Exide Batteries of Canada, Ltd., and Mr. Walter G. Henderson, its secretary-treasurer, are also president and manager and secretary-treasurer respectively.

Applications of Storage Battery.

It has been truly said that the storage battery is "the heart of the electrical system" on the modern passenger automobile, power boat or motorcycle. Whether the battery is used for starting, or only for lighting and ignition, its dependability and its response are factors in the degree of satisfactory service rendered by the entire machine. Exide batteries are well calculated to render such a service as this. Their various types are distinguished by great starting ability and capacity per unit of weight and volume, these characteristics having been developed to the maximum consistent with reliability and durability.

But it would be a great mistake to think of an exide battery merely as a black box that starts and lights one's automobile, or supplies the power for a street truck. For great industries of all kinds, as well as the navies of many countries, rely on these batteries for their unfailing power. For example, when we use the telephone, the electric current that carries our voice over the wire is supplied by a storage battery, and the Bell Telephone, among other systems, makes use of the exide.

Or, again, note the part it plays when a great bridge moves. At a touch of the hand, the great cantilever lifts or the drawbridge swings so that the ship may pass The hand move a switch, and the current from an exide battery sets in motion the motor that does the work. In railway signals, too, the exide battery says the word that speeds the train in safety.

Out on the prairies, in the rural districts of the Dominion, on lonely mountain sides, in thousands of farmhouses, churches, schools and stores, the electric light current comes from exide batteries. Great numbers of small electric light and power plants are equipped with these batteries.

From lighting farms and starting automobiles to propelling submarines and firing big naval guns, exide batteries are playing a vital part, whether in the science of war or in the arts of peace. Wireless stations, on land and sea, have storage batteries for reserve power, and something like ninety per cent of the Marconi system, as well as the majority of Government and private plants, use exide batteries.

In short while, to the majority of us, a storage battery probably is known best in its relation to the starting and lighting of automobiles, it has an infinity of other uses. Most of us may think of it as a 45 lb. black box that saves the muscles in cranking a car and gives current for the lights on the road. But, to the men in the central power and lighting stations of man large cities, an exide battery is a huge thing tha would fill an ordinary house—for each cell weighs as much as three tons, and there are 150 cells to a battery.

Plant of the Parent Company.

Having said this much as to the fields of storage tery application, a few words as to the parent company of Exide Batteries of Canada, Ltd., should not be without interest. At the present moment, the plant of their parent company—the Electric Storage Battery Company—at Philadelphia is the most complete and the largest plant on this continent devoted exclusively to the manufacture of storage batteries and their accessories. It consists, in all, of twenty-three separate buildings, now occupied, the floor space in these buildings alone reaching the stupendous total of over 12½ acres! The employees in this enormous plant number many thousands. The new factory which is just being completed, as part of the mammoth plant, and which is intended for the production of automobile batteries exclusively, will have a capacity of 6,000 batteries a day. In addition to its works and general offices at Philadelphia, the Electric Storage Battery Company maintains branches in New York, Boston, Rochester, Pittsburg, Washington, Cleveland, Detroit, Cincinnati, Chicago, St. Louis, Kansas City, Denver, Minneapolis, San Francisco and Seattle. The distribution of products is assisted by over 1,000 distributors in the United States, thus extending its business into practically every locality in that country.

Like so many other vast concerns, the Electric Storage Battery Company started its operations in a very small way. It was towards the close of the year 1887 that a Frenchman, Clement Payen, came to the United States with a firmly-established idea that he had invented a storage battery which differed radically from, and was immensely superior to, all the then existing types. So strongly did the force of his arguments impress some far-sighted persons in Philadelphia that they thereupon secured from him, by purchase, the assignment of all his patents and patent rights. Within a few months a company was formed, a factory was secured, manufacturing operations were commenced and steps were taken to exploit the new storage battery under its trade-marked name of the "Chloride Accumulator." This term has, in fact, become synonymous with the highest type of storage battery practice. It is thus that the organization of the Electric Storage Battery Company took place in the year 1888. Its total number of employees, at the start, was only five. Some indication of what it has accomplished since then may be gained from the few brief and bold facts just stated above. For, in truth, from that day to this, the company has been in the forefront, not only in the perfecting of the storage battery in its electrochemical and mechanical features, but also in successfully demonstrating the value of its application to the many new and rapidly multiplying fields of applied electricity.

It was in 1900, with the manufacture of the "Chloride Accumulator" continuing on an increasing scale, that the Electric Storage Battery Company placed on the market, as the result of exhaustive scientific tests and large pecuniary expenditures its "Exide" battery. This battery is largely responsible for the popular success of the electric vehicle. Later developments in batteries for electric vehicle service placed on the market, in order, the "Hycap-exide," the "Thin-Exide," and, finally, in 1911, the "Ironclad Exide," which last-named has earned for itself an unassailable

reputation, the "Crocker Land Expedition," when it started for the North Polar regions carrying with it a battery of "Ironclad Exide" cells, which, after 4,000 miles of the toughest transportation a battery ever suffered, were used ti light its permanent winter headquarters, and ,through five months of frozen nights afforded a light that never failed to shed its gladdening cheer.

It ought, in common fairness, to be added that a very large measure of the Electric Storage Battery Company's phenomenal success is attributable to its president and general manager, Mr. Herbert Lloyd, who is, by the way, an Englishman by birth, and who, on every side of the company's progress and activities, has displayed a combination of qualities amounting to real and rare genius.

From what has been said of the Electric Storage Battery Company's remarkable rise and progress, it may, with some confidence, be anticipated that the advent of its daughter, the Exide Batteries of Canada, Ltd., should be a distinct gain to the industrial life of Canada. For there is every reason to apprehend that the latter concern is imbued with the same enthusiasm, alike for scientific and far material progress, which has inspired the former. At present, the Exide Batteries of Canada, Ltd., employs some eighty persons, and has a capacity for some 600 batteries a day. But one is much mistaken if the scope and sphere of its operations will not, in a very short space of time, once normal conditions, industrial and commercial supervene, be on a largely extended scale. At all events, Mr. Bentley, the manager, in the course of a conversation with the writer, showed himself very optimistic as to the future, in this country, of the concern with which he is identified. Of course, at this actual moment, as can readily be understood, its business must be largely predicated on the prosperity of the automobile industry. But, naturally, a concern with affiliations of such calibre and such magniture, does not look to the present moment merely. And it is the concensus of informed opinion that the lack of briskness in the motor-car industry is pretty near its end, and that, in the coming year, we shall see a revival of prospect. Right here, it may be queried whether such a revival would not be appreciably hastened were someone, with sufficient nerve, to advance the price of the car—for it is pretty general experience that it is the rising market that induces the increased demand.

As to the reasons which induced the Exide Batteries of Canada, Ltd., to locate in Canada, prominent among them was the desire to respond to Canadian sentiment in favor of a "Made-in-Canada" product. Further, there was a wish to make it possible for the Canadian motor-car manufacturer and the Canadian motor-car owner to obtain this high standard of battery without paying the relatively high price that would be necessary, if the Canadian Customs duty had to be added to the cost of manufacture. In these circumstances, Toronto was selected as a location because it was a convenient point for shipment from Philadelphia. But, beyond these considerations, the parent company, no doubt, felt that it was incumbent that the Canadian market should be handled at close range—that things had reached a point when it was advisable, in its own interests, that its sales and sales promotion should be handled by its own trained experts rather than through jobbers who possibly might not be as familiar with the most effective methods of sales promotion, for its particular products, as its own men.

THE LAKE ATHABASCA IRON DISCOVERY.

By E. L. CHICANOT.

Probably no reported mineral discovery for some time has received such notice and attention as that of the iron ore deposits on the shore of Lake Athabasca. Taken up by the newspapers the phrase "an entire valley of iron ore" naturally caught the popular eye and kept on spreading. But this same lack of modesty in announcing the find has caused the report to be regarded very sceptically and handled very carefully by geologists and mining men whilst acknowledging the distinct possibility of a rich find in that locality.

As first published in the newspaper and circulated from there E. A. and N. C. Butterfield, father and son, had, in the course of their prospecting in the North country encountered a valley of iron on the shore of Lake Athabasca, of which they stated they had measured off 150,000,000 tons. Furthermore, they stated that there was 1,000,000 tons of the ore lying loose on the ground without any mining being necessitated, and this adjacent to excellent water transportation. The two filed six claims, each of 2,640 feet square, comprising in all nine hundred acres.

It is questionable is this find warrants the name of "discovery" as the occurrence of ore on the shore of Lake Athabasca was noted and examined by J. B. Tyrrell as far back as 1893. More detailed examinations were made by parties under F. J. Alcock, of the Geological Survey of Canada in 1914 and 1916, to be found in the summaries of the work of the Survey for those years.

The 1914 report of this area says: "Hematite is found in the Tazin series and some years ago a number of mining claims were staked on it. The hematite consists of bedder deposits associated with the quartzite, but there has been a great amount of secondary deposition with the formation of veins of hematite in fractures and joints in the quartzite. An analysis of this hematite showed 66.7 per cent iron, but the amounts seen were entirely too small to be of economic importance." The 1916 report states: "At several places the Tazin series contains considerable quantities of hematite and a number of claims have been staked on these deposits. Analysis showed iron 66.70 per cent, silicon 2.12, phosphorus 0.014, sulphur 0.013 per cent."

When the Butterfields came out of the North country to Edmonton, after staking their claims, they brought with them some surface specimens which were examined by officials of the University of Alberta, who pronounced them to be hematite of excellent quality with the following analysis:

Silica	21.36	20.94
Iron oxide	70.58	70.84
Phosphorus	0.029	0.031
Sulphur	0.063	0.082
Equivalent in iron of above oxide	49.40	49.58

It must be borne in mind that these were surface hand specimens examined, not giving an idea of the tenor of the ore over any area. The ore is, however, excellent hematite, as examined, containing about fifty per cent metallic iron, and if this represents anything like the general tenor a deposit of great commercial value has undoubtedly been discovered.

A certain amount of scepticism prevails over the extent of the reported find, especially in the face of the fact that the Geological Survey has stated specifically that there is no commercial quantity of ore available in any one area. How specific figures were

arrived at is open to t great deal of speculation, and it does not seem possible that 150,000,000 tons should be even roughly accurate. The probability of the idea to be conveyed is the existence of a very large body.

Whatever the truth of the situation may be it will not be revealed until spring, when it is confidently expecte dthat mare exhaustive investigations will be conducted by competent authorities. Mining men are unanimously of the opinion that such a step is warranted. In addition to the Dominion Government, it is reported that the University of Alberta will also send out an expedition.

The value of a large deposit of iron in this area would be a very valuable asset to Alberta and to the Dominion. Its reported location is in close proximity to the deep waters of Lake Athabasca, and an extension of the Alberta and Great Waterways Railway for one hundred and fifty miles would bring the ore to the Edmonton market sufficiently near to the vast coal fields of Alberta. In this connection it is interesting to note that Mr. Butterfield and his son were some years ago responsible for the discovery of 100,000,000 tons of Coking coal in the Brazeau district of Alberta, which deposits are said to be excellently adapted to the treatment of iron ore.

It is needless to point out just how important the establishment of iron and steel industry in the province of Alberta would be when Canada imports ninety-five per cent of the ore smelted in its blast furnaces, and also imports more than $125,000,000 worth of steel products. A short while ago the Butterfields passed through Montreal en route to New York, where they are taking up with a corporation arrangements for the commercial development of the property they have staked. Whether anything comes of this or not it is of the highest importance that this new discovery, which indicates certain possibilities, should be given the closest and most thorough investigation.

BRITISH INDUSTRIES FAIR.

The eighth annual British Industries Fair, which embraces a large number of the most important lines of British trade, will be held in London and Birmingham from 27th February to 10th March. This is purely a trade fair where buyer and seller meet, not an exhibition. This fair, whether regarded from the point of view of size, diversity of products shown, or resultant business, now surpasses in importance and value to the world's markets any other trade fair or similar purpose. A visit to the fair will convince overseas buyers that enormous strides have been made in Britain's post war production. A considerable number of Canadian buyers are making arrangements to attend. Admittance is restricted to trade buyers on invitation of the British Government, and business is not impeded by crowds of sightseers.

The British Industries Fair covers the following industries in London:—

Cutlery; silver and electro-plate; jewellery, watches and clocks; hard haberdashery; glassware of all descriptions; china, earthenware and stoneware; paper; stationery and stationer's sundries and office appliances; printing, books; fancy goods, including travelling requisites and tobacconists' sundries; boots and shoes and shoe mercery; leather for booth and shoe, fancy goods, bookbinding and upholstery trades; brushes and brooms; toys and games; sports goods (including sports clothing); scientific and optical instruments; medical and surgical instruments and appliances; spectacle ware and opticians' supplies; photographic and cinematographic apparatus and requisites; musical instruments; furniture of wood, cane, wicker; bedsteads and bedding; carpets, linoleum, etc.; basketware chemicals, light and heavy; domestic chemical products; drugs and druggists' sundries; perfumery; dyes; foodstuffs (prepared and preserved) and beverages; confectionery (sugar and chocolate); tobacco, cigarettes and cigars.

At Birmingham:—Lighting plant for electricity, gas, oil, etc.; cooking stoves and utensils, including aluminum, enamelware, etc.; foundry appliances; general hardware, including builders, marine and household ironmongery of all descriptions; general machinery of all descriptions and small tools mill furnishings; india rubber goods for industrial and household purposes; motor cycles and cycles; accessories for motor cars, cycles and aeroplanes; weighing and measuring appliances and instruments; sanitary appliances; paints, colours and varnishes and painte requisites; railway equipment; metals of all descriptions (including precious metals); agricultural and horticultural machinery and implements; mining, colliery and quarrying plant; brewing and distillery plant; metal furniture for house, shop, office, garden and camp use, including bedsteads, building construction; perambulators, mailcarts and push-chairs; saddlery and harness; firearms; fishing tackle and rods; tubes in copper, lead, brass and steel and steam and pipe fittings; architectural and ornamental metal work, including gates and fencing; ropes of steel and hemp, cordage and string.

IRON ORE, PIG IRON AND COKE.

Ontario Production for First Nine Months of the Year.

Apart from a 22-ton sample lot of hematite from the Wallbridge mine near Madoc, and 27,753 tons of nodulized siderite shipped by the Algoma Steel Corporation from the Magpie mine to Sault Ste. Marie blast furnaces, there were no shipments of iron ore. The shipment was from stock pile, the Magpie mine having been closed down since March 9th.

During the period seven blast furnaces were in operation, as follows:

Company	Location	Furnaces Operated	Average time, days
Algoma Steel Corp.,	Sault Ste. Marie ..	3	173
Steel Company of Canada,	Hamilton....	2	190
Canadian Furnace Co.,	Port Colborne ..	1	94
Midland Iron & Steel Co.,	Midland	1	41

A total of 537,475 tons of iron ore were smelted, of which 109,227 or 20.9 per cent was of Ontario origin. Pig iron produced totalled 393,303 tons, valued at $9,936,597. Of this quantity 230,857 tons, in addition to 176,666 tons of old material, were used in steel making, the output of steel being 364,602 tons, valued at $13,056,376.

The Algoma Steel Corporation operates 160 and the Steel Company of Canada 80 by-product coke ovens, using imported coal. The total coke consumed by Ontario blast furnaces was 421,434 tons, valued at $4,114,118. By-product ovens were charged with 593,359 tons of coking coal, worth $3,989,531. The coke product was 390,717 tons, worth $4,054,196, and the total value of by-products was $1,006,055.

Starting Early to Know Iron and Steel

By Frank Hilton Madison.

School children in Chicago are taught about iron and steel, not by studying text-books, but from actual specimens — raw materials in various stages of treatment and finished products. They see various iron ores, pig iron, open hearth and Bessemer steels and learn something of their qualities and principal uses. Their parents too learn something of this when they visit the community centres in the school buildings at night. Inasmuch as the plan used in Chicago is about to be adopted in other cities, the next generation ought to be better educated as to the economic value of iron.

Several sets of portable exhibits on "The Ores of Iron" and "Structural Steel" are among the hundreds of interesting cases circulated through the grammar and high schools and the ex-service men's vocational schools of Chicago by the N. W. Harris Public School Extension of the Field Museum of Natural History. In the course of a school year they are studied by from 300,000 to 500,000 persons.

Iron ores and steel specimens are probably included in many museum exhibits. But people try to "do" a museum in a day or less, therefore the economic exhibits have little chance for attention when they compete with the animals and birds. Children — the next generation of users of iron and steel — are generally in a holiday mood when they visit the museum. Although school children are always admitted free, less than a tenth of the Chicago pupils visited the Field Museum each year.

When he became impressed with the idea that the children would study natural history and economic specimens if they were put into the schools and thereby become more interested in school work, the late N. W. Harris, prominent Chicago banker, consulted the best teachers and sociologists available. Then he established a $250,000 foundation for the Field Museum to be used for circulating through the schools of Chicago portable exhibits of economic and natural history specimens.

In carrying out this plan to make study attractive, Dr. S. C. Simms, curator of the N. W. Harris Public School Extension, has used: "Wha would a boy or girl want to know about this?" as a guiding principle. Latin names of "families" to which specimens belong are not used. Earlier newspaper training has led Doctor Simms to write straight to the point labels that give information about the sources of materials, tell plainly of processes and explain the uses.

Iron and steel, as well as other specimens, are shown in handsome glass-covered mahogany cases, 24 inches long, 21 inches high and 7 inches deep. These are displayed on special racks in the class-rooms. Specimens are mounted on black-painted thin wooden tablets, usually 3 x 5 inches. Powdered material is put into glass-lidded box containers mounted like the tablets. Like the merchant's show window, the "goods" are up near the glass where they can be studied. Each specimen is plainly labeled. For instance the "Structural Steel" cases contain: Section of bar of open hearth steel; section of rail, Bessemer steel; slag; coke; limestone; Portland cement made from slag and lime; hard iron ore; soft iron ore; pig iron (miniature).

Large framed descriptive labels project on each side of the cases. These labels slide into the cases when they are being transported from school to school. One of these labels in a little more than 200 words tells something of making steel:

"Structural or mild steel is a very pure form of iron. It and wrought iron are the two purest forms in ordinary use, while pig or cast iron is the most impure.

"Structural steel is made from pig-iron by purification, and is called Bessemer Steel or Open Hearth Steel, according to the mode of purification employed. Pig iron with its other impurities contains much carbon absorbed from the coke of the blast furnace. In steel-making the most important thing is to remove all but a very minute portion of this carbon.

"For Bessemer Steel, melted pig iron is poured into a Bessemer converter, a vessel of peculiar form, and air is blown through it until carbon and most of the other impurities of the iron are burned away. Steel without any carbon would be too soft for most uses: so it is 'recarbonized' by adding a small weighed quantity of a substance containing carbon. The steel is then cast into ingots which are rolled hot into the form of rails, rods, plates, etc.

"For Open Hearth Steels the pig is treated in an Open Hearth furnace by the addition of scrap steels and iron ore. These remove carbon and the other impurities of the pig metal by chemical action.

"Bessemer and open hearth steels are tough, relatively soft, and, compared with other steels, cheaply made. They are used for rails, beams, boiler plate, wire and tin plate, but are not suited for edge tools or similar uses."

The other label on this case tells about pig iron and cast iron products, such as stoves, kettles and flatirons.

Another case entitled "The Ores of Iron" contains: magnetite, hematite, limonite, siderite and pyrite.

These cases of specimens and the labels are intended primarily to inoculate the children with an interest in iron and steel. The desire for more information is naturally whetted and search for more information generally follows. With the pupils writing compositions, airing their new-found knowledge at home, the cases going through all the rooms in a school, parents seeing them at community gatherings, new ideas about iron and steel are impressed upon the people of a neighborhood before the three weeks allotted to an exhibit have expired. At the end of that time the cases are picked up in a specially designed motor truck and carried to the next school while others of the many hundreds of exhibits are left in their places.

This plan of visual education will benefit the iron industry in a broad way if children are interested and kept in school until they have more of a chance to become better and more stable citizens. The next generations ought to have many good buyers and sellers of steel. Boys who have a natural liking for iron and steel and gravitate to the industry will make a desirable class of interested, efficient employes — the sort that infect others with their enthusiasm for their work.

And the plan is not likely to stop in Chicago. It has attracted attention of nationally known educators and government departments. Other cities, through their museums and schools, have shown active interest — among them Brooklyn, Philadelphia, Pittsburgh, St. Louis, Milwaukee, Cleveland and Los Angeles

J. D. IRELAND'S DEATH.

James Duane Ireland, member of M. A. Hanna & Co., Cleveland, and brother of Robert L. Ireland, who retired from the partnership in 1916, died in Cleveland Dec. 6, after an illness of about a year and a half. He had been a partner in the company since his brother's retirement and was in charge of the ore and anthracite coal operations of M. A. Hanna & Co. Prior to 1916, he was general manager of the Hanna iron ore properties with headquarters at Duluth, and had been with the organization since 1909. Mr. Ireland was a mining engineer, having specialized in precious metals mining in Colorado and Mexico following his graduation in 1903 from Massachusetts Institute of Technology with a degree of mining engineer. He had also obtained a degree of mechanical engineer from that institution in 1902 and in 1900 had been graduated from Sheffield Scientific School, Yale, as a bachelor of philosophy in mechanical engineering. He was 43 years old and was born and raised in New York city. Mr. Ireland was well known throughout the Lake Superior region, where he was, until a few years ago, in charge of the mining operations of the Hanna interests. His headquarters were in Duluth, but he made frequent visits to all the iron ranges and had many friends among the mining fraternity, all of whom were greatly grieved to learn of his death. Mr. Ireland was a member of the Lake Superior Mining Institute and several other organizations.

BOILERPLATE INDUSTRY FOR WELLAND.

The Weeks Engineering Corporation, an American organization, has decided to establish a plant at Welland. The principal product of the Canadian works will be boiler plates. The company is taking over the Welland Machine & Foundries property and will install machinery almost immediately. Additional buildings will be erected next spring, and the entire site, consisting of four acres, provides room for expansion. A by-law will be submitted to Welland ratepayers in January providing for a fixed assessment of $20,000 for 10 years.

NEW RAIL ORDER FOR ALGOMA STEEL.

Algoma Steel Corporation has been awarded a contract for 6,000 tons of standard rails for the T. & N. O. Railway, in connection with its extension. Tenders were called for the middle of last week, and the award was announced at the week-end. This latest order comes in addition to the Grand Trunk rail business announced a week ago, and together with the C. N. R. and C. P. R. placings, gives a substantial tonnage on the books of the Algoma Corporation, guaranteeing fairly active production for the balance of the winter season.

NICKEL INDUSTRY DEPRESSED.

The resignation of A. D. Miles, president; G. E. Sylvester, assistant to the president, and W. M. Dennett, assistant treasurer of the International Nickel Co. of Canada, a subsidiary of the International Nickel Co., is announced. The Toronto offices of the company are being closed. These developments are a part of a general change in the system of administration. There has been extreme depression in the nickel industry of late, all the company's works in the Sudbury district and the refinery at Port Colborne having been closed down for some time.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

DEMAND FOR MACHINE TOOLS IN INDIA.

In a recent issue of "Machinery" there appeared the following interesting article by George Cecil on the above subject.

There was a time when European employers of native labor in India did not encourage the use of imported tools; and the obstinate native mechanic also, for many years fought shy of modern tools and methods, anything in the way of a time-saving device being objectionable to him. The longer he worked, the greater his profit, so he thought; consequently, he allowed his task to drag on. Finally, employers and mechanics alike more or less fell into line with the new order of things, and today machine tools have been adopted in the mill repair shops; indeed, many of them are particularly well equipped.

India being preeminently conservative, this result was not achieved without a severe struggle. The native argued that his father, grandfather, and great-grandfather had used tools of Indian manufacture, and nothing would, at first, induce him to desert those to which he had been accustomed from his youth. But by degrees contractors and other employers of labor came to the conclusion that "time is money." Today, though the old-fashioned users of native tools refuse to bend their knees to progress, they are, fartunately, in a minority. As to the European concerns, both large and small, they expend money freely in acquiring suitable tools, a certain pride being taken in the shops.

General Industrial Conditions.

Of late, India has, for an Eastern country where progress seldom is encouraged, been unusually active industrially. Some of the railway companies, for example, have constructed their own locomotives with good results. For many years past, most companies have made their own cars, India being rich in suitable lumber. The shops are well equipped, and skilled European foremen, brought from England, are in charge. Under their fostering care the natives, who are employed by the thousand, often do very good work —they can, in fact, hardly be excelled. When, however, a supposed economy is effected by putting an incompetent and inexpensive half-caste native in charge, the quality of the output usually falls off. The semi-white man is naturally indolent; he seldoms masters the use of the machinery entrusted to his care, and the men dislike working under him.

Some of the small native shops in which machine tools are used serve apparently as an outlet for mere rubbish in the way of tools and machines. Obsolete contrivances, instead of being "scrapped," are purchased for a trifle by the economical Indian mill or mine owner, and those who use them are but poorly acquainted with their operation. One finds an antiquated lathe in a repair shop, with a venerable native endeavoring to operate it. The lathe is coated with rust; so, too, is the mind of the operator.

Types of Machine Tools in Demand.

A small percentage of the machine tools in local use are manufactured in India, but the number imported is b far the most important. Milling and drilling machines and woodworking machinery are in demand; light gap lathes (12-inch swing), heavier gap lathes (16-inch swing), screw machines, bolt- and nut-making machinery, shapers, and saws are needed. Woodworking machines are used in Calcutta, Bombay, Madras and elsewhere. The market, while not unlimited, is well worth the exporters' close attention. India has many capitalists, both native and European. With a little urging, they are often are ready to lunch out upon new enterprises.

Both Japan and Germany have made frantic efforts to capture the Indian market. The Japanese products, unfortunately, seldom are like the samples, or representations made. German manufacturers have not always kept their word, a failing which neither European nor native machinery users are inclined to tolerate. The Indian himself may not be a model of all the virtues; but he has a great admiration for the exporter whose honesty is unassailable; and it must be confessed that during many years' trading with India, Germany has scarcely earned a reputation for upright dealing.

Small Tools in Demand.

The demand for small tools is considerable. The European tea and indigo planters provide themselves with tool-chests, for in many cases the exiled agriculturist is far from the haunts of the native mechanics. Missionaries are in the same positon, the government officials who find themselves in isolated spots are forced to upervnse, if not to undertake, domestic repairs. Well-stocked tool-boxes may be found in the large hardware establishments, but they seldom include everything that is required. A really complete box would need to be very large—a miniature shop. It should contain everything by means of which the possessor may perform temporary repairs of all kinds—both in wood and metal—and should include even a lavish supply of nails and screws. As to the nature of the tools used in India, they are the same as those required in other countries. The native, though haggling over prices, knows when he is getting value for his money.

Dealers in Machinery and Tools.

In the three main cities, Calcutta, Bombay, and Madras, there are many reputable machinery and small tool dealers. They generally know their business, and they are as active as the enervating climate permits them to be. The consul at each town should be in a position to vouch for their standing and capabilities. Calcutta and Bombay support hardware establishments of repute, all of which deal largely in small tools. Both the machinery agents and the hardware men are in a position to know what is wanted, and they possess the necessary means of distribution. Their travellers constantly are on the move; they are in complete touch with requirements—both European and native. Consequently, the manufacturer who aspires to conquering the Indian field may safely leave his interests in their hands.

The large mercantile houses also are ready to undertake agencies for the sale of anything—"from a needle to an anchor." Jute firms, cotton firms, wine merchants, even tailors—all are willing to pose as agents for lathes and drilling machines, hammers and nails. These people are of course, worse than useless as agents or representatives.

A number of automobile manufacturers in France have recently former a combination known as L'Union Commerciale des Marques Francaises, capitalized at 1,500,000 francs. The object of this organization is to develop foreign markets by securing capable agents throughout the world for automobiles; it is stated that the organization will also handle machinery in general.